IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant	:	Marie B. CONNETT-PORCEDDU	
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Customer No.	:	6449	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER RULE 132 OF MARIE B. CONNETT-PORCEDDU

Dear Sir:

I, Marie B. Connett-Porceddu, declare as follows:

1. I am the inventor of the subject application.

2. My education and experience are as follows. I received a Bachelor of Arts degree in Biology from Humboldt State University in 1984 and a Doctorate degree in Botany from Cornell University in 1991. I have been employed by Arborgen, LLC, which is a joint venture including Westvaco Corporation, the assignee of the present application, from August, 2002 to present. I held the positions of Scientist and Senior Scientist with Westvaco Corporation from 1998 to August, 2002. I was employed by Fletcher Challenge Forests from 1994 to 1997, first as a Molecular Biology Manager and then as a Biotechnology Manager. I was employed by New Zealand Forest Research Institute from 1992 to 1994 as Program Manager, Molecular Biology. I have been involved with tissue culture and transformation of pines since 1992.

3. I understand that the claims recite a method for regenerating genetically modified plants of pine of the genus *Pinus* selected from the group consisting of Southern yellow pines and hybrids thereof. This method provides for enhanced regeneration of transgenic embryogenic pine cells for this important group of pines.

4. I have recently reviewed this application and the Office Action mailed January 28, 2003 and the Office Action mailed 3 July 2003. I have also recently reviewed the Wenck et al. (*Plant Mol Biol* 39:407-416, 1999), Levee et al. (*Molecular Breeding* 5:429-440, 1999) and Rutter et al. (US 5,731,204) references cited in the Office Action. I have also reviewed amended claims to be filed with this Declaration.

5. I understand that the Examiner has stated that the claimed invention is unpatentable because it is anticipated by Wenck et al. because Wenck et al. "use Phytagel, which is a gelling agent and the 471 medium which they use comprises nutrients which act as an osmoticum." Office Action at page 4.

6. I also understand that the Examiner has stated that the claimed invention is unpatentable over Wenck et al. and Rutter et al. because it would have been obvious to persons skilled in the art to use the abscisic acid (ABA) and polyethylene gycol (PEG) of Rutter et al. in the selection medium of Wenck et al. for the reasons set forth in the Office Action mailed 3 July 2002, which stated: "it would have been obvious to modify this method [Wenck et al.] by incorporating the abscisic acid, polyethylene gycol and gellan gum to enhance the efficiency of transformation and regeneration of pine plants." Office Action mailed 3 July 2003 at page 5.

7. I further understand that the Examiner has stated that the claimed invention is unpatentable over Wenck et al and Levee et al. because it would have been obvious to persons skilled in the art to use the support membrane of Levee et al. in the method of Wenck et al. for the reasons set forth in the Office Action mailed 3 July 2003, which stated: "it would have been obvious to modify this method [Wenck et al.] by culturing the embryogenic suspension-cultured cells on a support membrane comprising filtering the liquid medium and cells through a filter (i.e. support membrane) supported by a Buchner funnel and then placing the support membrane on medium containing a selection agent and chemical to eradicate *Agrobacterium* as taught by Levee et al." Office Action mailed 3 July 2002 at pages 6-7.

8. I also understand that the Examiner has stated that the claimed invention is unpatentable over Wenck et al., Levee et al. and Rutter et al. because it would have been obvious to persons skilled in the art to use the support membrane of Levee et al. and the ABA of Rutter et al. in

the method of Wenck et al. for the reason set forth in the Office Action mailed 3 July 2003, which stated: "it would have been obvious modify this method [Wenck et al.] by culturing the embryogenic suspension-cultured cells on a support membrane comprising filtering the liquid medium and cells through a filter (i.e. support membrane) supported by a Buchner funnel and then placing the support membrane on medium containing a selection agent as taught by Levee et al. and including in the media abscisic acid as taught by Rutter et al." Office Action mailed 3 July 2003 at page 8.

9. Applicants have invented a method which provides enhanced regeneration of transgenic embryogenic pine cells in which the pine is a Southern yellow pine or a hybrid thereof. These pines belong to the genus *Pinus*, subgenus *Pinus*. Pines of the subgenus *Pinus* are hard pines. See Little and Critchfield, 1969, *Subdivision of the genus Pinus (Pines)*, USDA Forest Service Miscellaneous Publication 1144, Washington, D.C. (copy attached as Exhibit 1)). The method involves selecting transgenic embryogenic pine cells using a selection medium that contains a selection agent and an agent that regulates differentiation. The differentiation-regulating agent may be ABA, PEG, a gelling agent in an amount of 0.5%-1.5% or an amount of 3%-5%, or mixtures thereof. Applicants discovered that, through the use of the disclosed and claimed method, they were able to select and regenerate transgenic pine plants of Southern yellow pines and hybrids thereof. These pines belong to the *Pinus* subgenus, i.e. hard pines. Applicants' invention allowed for the first time the efficient regeneration of transgenic plants of these economically important pines at significant frequency from transgenic pine cells.

10. The efficient regeneration of transgenic plants of Southern yellow pines is demonstrated by comparing regeneration frequencies for transgenic Southern yellow pines and hybrids thereof regenerated in accordance with the method of the present invention, i.e., the use of ABA, PEG or gelling agent concentration in the selection medium, which contains a separate selection agent. Comparisons were made between the regeneration of plants using standard conditions of the prior art for selection and the regeneration of plants using the selection conditions of the present invention, i.e., the use of ABA, PEG, gelling agent of specified concentrations or mixtures thereof. The comparison is shown in Table 1.

Table 1

Improvement in Regeneration on Basis of Selection Conditions*

Conditions	P. taeda	Elite Families
Standard	26%	0%
Invention	71%	80%

* n = 76 lines chosen at random from 7 families; transformants verified by PCR and/or Southern blots

11. As shown in the present application, genetically modified plants are obtained using the claimed method in which transgenic embryogenic pine cells of Southern yellow pines or hybrids thereof are selected on a medium containing a selection agent and the specified agents that regulate differentiation, i.e., ABA, PEG, gelling agent in the specified amount or mixtures thereof. Wenck et al., on the other hand, specifically teaches that genetically modified plants of Southern yellow pines had not been obtained. Specifically, Wenck et al. at page 413, bottom of left column with respect to loblolly pine, a Southern yellow pine, states: "[w]e have not been able to recover stable transformants through selection to date." Thus, the method described in Wenck et al. did not produce genetically modified plants of Southern yellow pines or hybrids thereof.

12. Rutter et al. describes a method for regenerating pine plants from tissue culture. This method involves the use of PEG and ABA, as well as a cold treatment step. The prior art method of using PEG and ABA did not result in the germination of somatic embryos. See column 3, lines 59-67. Rutter et al. does not describe a method for the selection of genetically modified pine cells, i.e., the selection of transgenic embryogenic pine cells, of Southern yellow pines or hybrids thereof, nor does it describe a method for regenerating transgenic embryogenic pine cells. Since Wenck et al. did not regenerate genetically modified plants from selected transgenic pine cells and Rutter et al. does not select transgenic pine cells and does not regenerate plants from selected transgenic pine cells, it is my opinion that a skilled artisan would have no expectation of success for modifying the method of Wenck et al. to regenerate genetically modified plants of Southern yellow pines or hybrids thereof.

13. Levee et al. discloses the transformation and regeneration of pine of the subgenus *Strobus* which, according to this reference, "is the first work on genetic transformation on **this pine species** as well as the first report of successful stable genetic transformation of **a pine species** using a disarmed strain of *A. tumefaciens*". (See page 36, first paragraph of Discussion, emphasis added). Levee et al. does not disclose the transformation and regeneration of any pines of the subgenus *Pinus*. In addition, Levee et al. does not teach the use of ABA, PEG or a gelling agent in the specified amount in the selection medium with a selection agent for selecting transgenic pine cells of Southern yellow pines or hybrids thereof. Nor would a skilled artisan expect that the method disclosed by Levee et al. for soft pines could be used or routinely modified for use with hard pines.

14. Specifically, it was well known at the time of the present invention that there were differences between soft pines and hard pines. These differences were seen in transformation and regeneration methods for soft pines and hard pines, such that there was no expectation of success with respect to the transformation and regeneration of hard or soft pines on the basis of the other. There was no publication describing any regeneration of plants from cultures of transgenic hard pines using *Agrobacterium* at the time of the present invention. This knowledge and lack of expectation of success is described in detail in my Declaration Under Rule 132 filed in connection with companion application Serial No. 09/973,088. A copy of this Declaration is attached as Exhibit 2. This knowledge and lack of expectation of success is also briefly described in the Declaration Under Rule 132 of Dr. Michael Becwar filed concurrently herewith.

15. Since Wenck et al. did not regenerate genetically modified plants from selected transgenic pine cells and Levee et al. does not select transgenic pine cells of Southern yellow pines or hybrids thereof and does not regenerate plants from the selected transgenic pine cells, it is my opinion that a skilled artisan would have no expectation of success for modifying the method of Wenck et al. to regenerate genetically modified plants of Southern yellow pines or hybrids thereof.

16. Since Wenck et al. did not regenerate genetically modified plants from selected transgenic pine cells, Levee et al. does not select transgenic pine cells of Southern yellow pines or hybrids thereof and does not regenerate plants from the selected transgenic pine cells and Rutter et al. does not select transgenic pine cells and does not regenerate plants from selected transgenic pine

cells, it is my opinion that a skilled artisan would have no expectation of success for modifying the method of Wenck et al. to regenerate genetically modified plants of Southern yellow pines or hybrids thereof.

17. In summary, Wenck et al. does not teach the regeneration of genetically modified Southern yellow pines or hybrids thereof. Rutter et al. does not teach (a) the selection of transgenic cells of Southern yellow pines or hybrids thereof and (b) the regeneration of genetically modified plants from such cells. Levee et al. does not teach the regeneration of transgenic hard pines, such as Southern yellow pines and hybrids. Thus, there was no expectation of success for modifying the method of Wenck et al. to regenerate genetically modified pine plants from selected transgenic cells of Southern yellow pines or hybrids thereof.

18. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or of any patent issued thereon.

7-14-04
Date

Marie B. Connett-Porceddu

2411-111.Rule 132 Decl A.doc

Notary - July 14, 2004 Dorchester County

Janis H. Orze
Comm Exp 4-13-12

Subdivisions of the Genus *PINUS* (Pines)

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Subdivisions of the Genus *Pinus* (Pines)

By Elbert L. Little, Jr., and William B. Critchfield [1]

INTRODUCTION

A summary of the nomenclature and 22 distribution maps of subdivisions of the genus *Pinus* L., pine, are presented here to supplement Miscellaneous Publication 991—Geographic Distribution of the Pines of the World, with maps of 94 species (Critchfield and Little 1966). Important synonyms and lists of the species are included, and the slight changes in the classification of the subdivisions are explained. The maps of subdivisions combined from those of individual species show clearly and graphically the maximum natural range of all component species. These compiled maps of groups of related species may be useful in further researches, particularly in classification, geographical distribution, tree breeding and introduction, and evolution.

In recent years several revised classifications of the genus *Pinus* have been proposed, some emphasizing anatomy of needles (Jahrig 1962), of wood (Hudson 1960), and of cotyledons (Ferré 1965). Others, such as those by Ishii (1952) and Gaussen (1960), represent new interpretations based upon various, mostly morphological characters. Numerous interspecific hybridization tests at the Institute of Forest Genetics, Placerville, Calif., and elsewhere, have suggested modifications of the classification according to crossability. The slightly revised classification adopted here incorporates these changes.

A check of the nomenclature of the subdivisions of the genus *Pinus* is needed to determine the correct names under the International Code of Botanical Nomenclature (Lanjouw 1966). These mostly retroactive rules have been changed since some names were published, and some recently published names are not in accordance with the Code. Some problems in determining the correct section names in a large genus have been noted recently by Burtt (1966). A few older classifications and names have been overlooked or passed over by other workers. The earlier subdivision names were not indexed or covered by rules. Naturally, many names published for remodelled groups were superfluous. A few arrangements were merely convenient groups of the species included in a publication, somewhat like the keys, and not intended as revisions of nomenclature of the genus. The number of ranks between genus and species in the genus *Pinus* has varied in time and among authors. When the rank of a taxon is changed, competition for priority begins anew.

In an effort to bring the nomenclature up to date, we have compiled the significant synonymy, chosen a few lectotype species as needed, and have emended or altered some groups in diagnostic characters and in circumscription. Names established in usage have been retained so far as possible.

Slight changes in the classification of Shaw (1914, 1924) were adopted in the recent publication (Critchfield and Little 1966), and an explanation is offered here. The three ranks of subdivisions recognized here within the genus *Pinus* are subgenus, section, and subsection. A separate subgenus (with section and subsection) is accepted for *Pinus krempfii* Lecomte, as Ferré (1953, 1965) and Gaussen (1960) proposed. The important revision by Duffield (1952) of *Pinus* subsection *Pinaster* has been followed except for his union of one small group. The needed scientific names have been assigned to Duffield's four groups XI–XIV, which were designated merely by roman numerals. Accordingly, we proposed three new names of subsections, *Pinus* subsect. *Krempfianae*, subsect. *Contortae*, and subsect. *Oocarpae*. Also, we validly published the combination *Pinus* subgen. *Ducampopinus* (A. Cheval.) de Ferré (1953) with full reference to original publication. *Pinus* subsect. *Pineae* is validly published here.

REVIEW OF INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE

The more important Articles in the International Code of Botanical Nomenclature (Lanjouw 1966) relating to nomenclature of subdivisions of generic names are Articles 4, 10, 21, 22, 33–37, 51, 60, 63, and 66. A brief review may be appropriate here.

The ranks of subdivisions of genera (ICBN Art. 54, footnote) are: Subgenus, sectio, subsectio, series, subseries (Arts. 4, 21), and the types are species (Art. 10). A name or an epithet does not have priority outside its own rank (Art. 60). An alteration of the diagnostic characters or of the circumscription does not warrant a change in names, with certain exceptions (Art. 51). An epithet

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must be rejected if its author did not adopt the earliest legitimate epithet available for the taxon with its particular circumscription, position, and rank (Art. 66). A name must be rejected if it was nomenclaturally superfluous when published, if the taxon as circumscribed by its author included the type of a name or epithet which ought to have been adopted (Art. 63). The subgenus or section including the type species repeats the generic name as its epithet but without the author's name, and a section including the type species of any subgenus must bear as its epithet the epithet of the subgenus (Art. 22). The epithet of a subgenus or section is preferably a substantive, that of a subsection or lower subdivision of a genus preferably a plural adjective (Art. 21, Rec. 21B). When the epithet is identical with or derived from the epithet of a constituent species, this species is the type (Art. 22, new paragraph added in 1966).

A few pertinent Articles are not retroactive. Names published after Jan. 1, 1935, must be accompanied by a Latin diagnosis or reference to a previously published Latin diagnosis (Art. 36). Names published after Jan. 1, 1958, are valid only when the nomenclatural type is indicated (Art. 37). A new combination published after Jan. 1, 1953, must indicate clearly the basionym with a full reference to its author and original publication (Art. 33). A new name published on or after Jan. 1, 1953, without a clear indication of the rank of the taxon concerned is not validly published, but for such names published earlier, the choice made by the first author who assigned a definite rank must be followed (Art. 35 and Note). The rank "group" (also "Gruppe," "groupe," and "grupo") is not mentioned (Art. 4). However, such names published before Jan. 1, 1953, have the first rank assigned by a later author (Art. 35, Note).

Some recently published names of subdivisions of the genus *Pinus* are superfluous and illegitimate because the taxa containing the type species have older names (Arts. 51, 63). If the genus *Pinus* should be divided, the name *Pinus* must be retained for one of the segregates, and the same general rule applies to remodelling subdivisions of genera (Arts. 51, 52). If a subdivision is remodelled by transfer of some species to or from it, the name must be retained for the taxon containing the type species. Fortunately, the holotype of most epithets was clearly designated by the derivation from the epithet of a species (Art. 7). When a section is divided, there may be available an earlier epithet of different circumscription but with the same type species. A second epithet of the same rank based upon the same type species is illegitimate, for example, *Pinus* sect. *Banksianoides* later than sect. *Banksia* (Arts. 63, 66). Likewise, a new classification of the genus *Pinus* with all epithets of sections new or with new endings must be rejected. Examples are the 10 sections proposed by Gaussen (1960) and the five sections of Hudson (1960). These last and some other recently published names must be rejected also because they were not accompanied by a Latin diagnosis.

THE GENUS *PINUS* AND ITS CIRCUMSCRIPTION

Pinus [Tourn.] L. is a classical Latin name. Tidestrom (Elys. Marian. Evergr. 72. 1908) cited Pliny as author. Lunell (Amer. Midland Nat. 4: 160. 1915) credited the authorship to Virgil (Ecl. VIII: 56; Georgica I: 141). *Pinus* L. (Sp. Pl. 1000. 1753; Gen. Pl. ed. 5, 434. 1754) originally contained 10 species: *sylvestris, Pinea, Taeda, Cembra, Strobus, Cedrus, Larix, Picea, Balsamea,* ar *Abies*. This genus united 3 pre-Linnaean genera *Pinus, Abies,* an *Larix* of Tournefort (Elem. Bot. 1: 457, t. 355–356. 1694). Earlie Linnaeus (Gen. Pl. ed. 1, 731. 1737; ed. 4, 357. 1752) had fo lowed Tournefort's narrower circumscription of *Pinus*. The lect typus, *Pinus sylvestris* L., was selected by Britton and Shafer (Nc Amer. Trees 5. 1908) and by Hitchcock and Green (Internat. Rules Bot. Nomencl. Brittonia 6: 117. 1947).

The genus was promptly remodeled and emended by Mille (Gard. Dict. Abridged. Ed. 4. 1754) who, while merely followin Tournefort and not citing Linnaeus, segregated *Abies* and *Larix* Later segregates were *Cedrus* Trew (Cedrorum Libani Hist. 4 1757) and *Picea* A. Dietr. (Fl. Berlin 794. 1824). However, after more than a century, Parlatore (in DC., Prodr. 16(2): 377–407. 1868) still used the broad, original circumscription of *Pinus* L. *sens. lat.* Nearly all contemporaneous specialists accept *Pinus sens. strict.* as emended by Miller. A few later generic segregates have also been proposed, as indicated in the synonymy, but have received very limited acceptance. Briefly, the genus *Pinus*, as almost universally defined, is distinguished from all other conifers by the needle-like leaves on dwarf shoots in fascicles of usually 2–5 with a sheath of bud-scales at base.

PRINCIPAL CLASSIFICATIONS OF THE GENUS *PINUS*

A review of the principal classifications of subdivisions of the genus *Pinus* in chronological order will indicate the available names and serve as a basis for determining the correct nomenclature. Compilations of names of subdivisions in the genus *Pinus* were made by Pfeiffer (Nomencl. Bot. 2: 722–723. 1874) and by Rehder (Bibliog. Cult. Trees Shrubs 32–41. 1949). The first ended with the year 1858. Rehder's Bibliography contains the most detailed synonymy available but covers only cultivated trees hardy in the cooler temperate regions and omits pines of warm temperate and tropical regions.

The first division of the genus *Pinus* after 1753 was by Duhamel (Traité Arbr. Arbust. France 2: 124–126. 1755). His three "sections," *Bifoliis, Trifoliis,* and *Quinquefoliis,* based upon number of needles in a fascicle or sheath, had brief French descriptions and appeared in both text and headings. These epithets not cited by later authors were validly published, even though the Linnaean system of binary nomenclature was not employed and the endings were in ablative case. Duhamel's first and third epithets are replaced automatically by those repeating the subgenera *Pinus* and *Strobus* (ICBN Art. 22). His second section can be rejected by union with the first.

Probably the first subdivision of *Pinus* L. *sens. lat.* to correspond to *Pinus* L. *sens. strict.* and repeat the generic name was *Pinus* I. *Pinus* Münchhausen (Hausvater 5: 215. 1770). David Don (Prodr. Fl. Nepal. 54. 1825) apparently was the first to propose *Pinus* [group] *Strobus* for a group of undesignated rank containing two species. Pfeiffer (Nomencl. Bot. 2: 722, 1303. 1874) designated the rank as section. This epithet is often credited to Sweet (Hort. Brit. ed. 2, 475. 1830), whose subdivisions in a table of species were *nomina nuda* without descriptions or indications of rank (Art. 34).

Loudon (Arb. Frut. Brit. 4: 2152–2292, illus. 1838), in a detailed classification overlooked by some later authors, divided the

genus into three sections, Sect. *Binae, Ternatae,* and *Quinae.* The first and third are now replaced by the epithets *Pinus* and *Strobus.* Sect. *Ternatae* is typified here to be a synonym of Sect. *Pinus.* Loudon introduced a second rank with 15 groups derived from specific epithets, designated by the symbol §, and described under "*Sect. Char.*" Examples are *Sylvestres, Taeda, Australes, Cembrae, Strobi.* As the symbol § generally means section, this rank below section corresponded to subsection.

Spach (Hist. Nat. Végét. Phan. 11: 369–403. 1842) divided the genus *Pinus* into 4 sections, *Eupitys, Taeda, Strobus* Sweet, and *Cembra.*

Endlicher (Syn. Conif. 81–183. 1847) in synonymy used the term subgenus, possibly for the first time in *Pinus.* He divided *Pinus* L. *sens. lat.* into two groups *Sapinus* and *Pinus* corresponding to subgenera and further into 11 sections ("sectio"), six of these within *Pinus sens. strict.*

Carrière (Traité Gén. Conif. 291–412. 1855; ed. 2, 381–589. 1867) substituted the rank tribe ("tribu") for section (contrary to Arts 4, 5, 33).

Gordon and Glendinning (Pinetum 162–267. 1858; ed. 2, 228–326. 1875) distinguished only the three sections proposed by Loudon, *Binae, Ternatae,* and *Quinae.*

Parlatore (in DC., Prodr. 16(2): 377–407. 1868) modified Endlicher's classification slightly. He recognized within *Pinus* L. *sens. lat.* subgenus *Pinus* the two sections ("sectio") *Pinea* and *Cembra,* the former subdivided into three groups of undesignated rank reduced from section, *Pinaster, Taeda,* and *Pseudo-Strobus.*

Koch (Dendrologie 2 (2): 269–325. 1873) divided *Pinus* into 6 groups ("Gruppe"), *Sabinea* being new.

Engelmann (St. Louis Acad. Sci. Trans. 4: 161–189, illus. 1880) in a brief key to the species accepted two sections *Strobus* and *Pinaster* and eight subdivisions designated by §. The six subdivisions under sect. *Pinaster* were further subdivided into 14 named groups of species and two unnamed groups of one species each. These subdivisions were called "subsections" (p. 175) and in the notes "subsection *Cembroides*" (p. 178), "*Australes* group" (p. 183, § on p. 177) and "*Pseudo-Strobi* group" (p. 185).

Bentham and Hooker (Gen. Pl. 3(1): 438–439. 1880) accepted only Engelmann's two primary sections but noted that Engelmann in correspondence had proposed 20 subsections. Eichler (in Engler & Prantl, Natürl. Pflanzenfam. 2(1): 70–74. 1889) distinguished the same two sections and five groups of a lower rank designated by §. Sargent (Silva No. Amer. 11: 4. 1897) accepted and further defined Engelmann's two sections and eight groups of lower rank.

Mayr (Wald. Nordamer. 425–428. 1890; Fremdl. Wald. Parkbaüme 340–390. 1906) developed a natural classification with 11 sections, six with new names.

Koehne (Deutsche Dendrologie 28–40. 1893) proposed the widely accepted division of the genus into two groups based upon the presence of one or two vascular bundles in the leaf or needle, Sekt. *Haploxylon* and Sekt. *Diploxylon.* These appropriately descriptive names of correct circumscription obviously lack priority and are illegitimate as section names under present rules, not repeating the subgeneric epithets, also not available under rank of subgenus. These sections were subdivided into six subsections ("Subsekt.") and the first two subsections also into two groups each ("Gruppe").

Lemmon (Handb. West-Amer. Cone-bearers ed. 3, 19–46. 1895) published a detailed, overlooked classification of *Pinus* in Western North America with four ranks: Subgenus, section, subsection, and "group." Apparently he was the first to use the rank subgenus for the two main subdivisions designated as sections by Engelmann, *Strobus* for softwood or white pines and *Pinaster* for hardwood pines. The first was subdivided into two named groups, and the second into two sections, two subsections, and seven groups. *Pinus* subgen. *Strobus* Lemm. is accepted here.

Masters (Linn. Soc. London J. Bot. 35: 560–659, illus. 1904) in a key grouped the species into divisions *Tenuisquamae* and *Crassisquamae* and further into 10 sections, five of them new.

Silva Tarouca (Unsere Freiland Nadelhölzer 235–265. 1913) adopted the rank "Hauptgruppe" for *Haploxylon* and *Diploxylon* and "Gruppe" for the nine subdivisions. In a later edition, Silva Tarouca and Schneider (Unsere Freiland-Nadelhölzer ed. 2, 240–271. 1923) followed Shaw (1914) but retained the same rank names and called the third rank "Reihe," corresponding to series.

In the classic monograph, Shaw (1914) distinguished two sections (*Haploxylon* and *Diploxylon*), four subsections (*Parapinaster* proposed as new), and 13 "groups" designated by name and roman number, partly taken from Engelmann and five new. Afterwards, Shaw (1924) united his group *Flexiles* with group *Strobi* and placed the newly discovered anomalous species *Pinus krempfii* Lecomte under group *Balfourianae.*

Apparently the first to elevate Koehne's two sections *Haploxylon* and *Diploxylon* to subgenera was Rehder (in Bailey, 1923, pp. 295–331), who should be credited as author. However, in a later publication, Rehder (Man. Cult. Trees Shrubs 53–66. 1927) cited Koehne. He raised Shaw's four subsections to sections but left Shaw's "groups" as such.

The transfers of *Haploxylon* and *Diploxylon* to subgenera generally have been credited to Pilger (in Engler & Prantl, Natür. Pflanzenfam. ed. 2, 13: 331–342, illus. 1926) rather than Rehder. Besides these two subgenera ("Untergatt.") Pilger distinguished 11 sections ("Sekt.") and two subsections ("Untersekt."). Fitschen (Beissner Handb. Nadelholzk. ed. 3: 326–433. 1930) modified Pilger's classification slightly, accepting nine sections and five groups ("Gruppe"). Melchior and Werdermann (Engler's Syllabus Pflanzenfam. ed. 12, 1: 331–332. 1954) followed Pilger with omission of the two subsections. Komarov (Fl. URSS. 1: 159–173. 1934) also accepted Koehne's two subdivisions as subgenera (podrod) and had five sections (sektsiia).

The requirement of Latin diagnosis for names of new groups published after Jan. 1, 1935 (Art. 36), results in rejection of many later names. Several later classifications merit mention, though the new names mostly are not in accord with the Code.

The rank series was first used in the genus *Pinus* apparently by Rehder (1940, pp. 34–40). He changed Shaw's groups to series but they were without author or Latin diagnosis. Afterwards Rehder (1949, pp. 32–41) made slight changes in names of several groups, proposed new combinations for the two subgenera *Strobus* (Sweet) Rehd. and *Eupitys* (Spach) Rehd., and adopted section and series for the two lower ranks. Krüssmann (Nadelgehölze 206–236. 1955; ed. 2, 220–257. 1960) followed Rehder.

Martínez (1945) arranged the Mexican pines into nine sections ("Sección") and six groups ("grupo") but without Latin diagnoses.

Mme. van Campo-Duplan (1950, p. 92, 94) in classifying the species of *Pinus* according to their pollen grains used for subgenera ("sous-genres") the names *Haplopinus* and *Diplopinus* but without description there.

Mlle. Yvonne de Ferré (1953) proposed with French descriptions four subgenera ("sous-genres") as follows: *Diplopinus* van Campo (*Diploxylon* Koehne), *Cembrapinus* de Ferré (*Cembra* Koehne), *Paracembrapinus* de Ferré (*Paracembra* Koehne), and *Ducampopinus* (A. Cheval.) de Ferré. The last, a new combination, did not cite the page of basionym.

Duffield (1952) made a major rearrangement of Shaw's classification of Subsection *Pinaster* on the basis of results of interspecific hybridization, designating four groups by roman numerals (XI–XIV) without scientific names.

Ishii (1952) proposed two new subgeneric names, Subgenus *Malacopitys* for the soft pines and Subgenus *Scleropitys* for the hard pines, both without Latin diagnoses. In a Japanese key to 82 species, he distinguished 13 sections, four of these new and without Latin diagnoses.

The most detailed recent classification was by Gaussen (1960), who did not supply Latin diagnoses. He accepted three subgenera ("sous-genre"), *Ducampopinus*, *Eupinus*, and *Cembrapinus*. Also his classification (p. 38) contained 10 sections with new names ending in *-oides* (*Krempfoides*, *Taedoponderosoides*, etc.) and 33 groups ("group") designated merely by specific epithets without Latin diagnoses.

Mirov (1961, p. 27; 1967) followed Shaw but rearranged the species and groups slightly according to composition of gum turpentines.

Jährig (1962) proposed a classification based mainly upon needle anatomy with a key to species. The two subgenera ("Untergattung") *Pinus* and *Haploxylon* were subdivided into 11 sections ("Sectio"), eight from Gaussen (1960) and three new but without Latin diagnoses.

Debazac (1964, pp. 82–112) accepted the three subgenera ("sous-genre") adopted here, *Pinus*, *Strobus*, and *Ducampopinus*, also eight sections and eight subsections ("sous-section").

Classifications based on wood anatomy have been relatively simple and composed of few groups. Phillips (1941) accepted the seven groups recognized by R. Rol in 1932. Greguss and Varga (1950) had nine groups ("Gruppe"). R. H. Hudson (1960) divided the genus *Pinus* into only five sections (without Latin diagnoses): *Cembra*, *Paracembra*, *Parapinaster*, *Pinaster-Lariciones*, and *Pinaster-Taedae*.

RANKS IN THE GENUS *PINUS*

Obviously, the nomenclature adopted for the subdivisions of the genus *Pinus* is dependent upon the number of ranks distinguished and their names. The three ranks accepted here are subgenus, section, and subsection.

Duhamel (1755) introduced section. Loudon (1838) had a second rank §, under which the description was headed "Sect. Char." and thus a second rank of section, or subsection. Engelmann (1880) distinguished three ranks, section and two ranks of subsections, the first designated by §.

Lemmon (1895) had four ranks: subgenus, section, subsection, and group. Apparently he was the first to use the rank subgenus for subdivisions within the present genus *Pinus* L. *sens. strict.*

Rehder (1940, 1949) introduced the rank series. His three ranks were subgenus, section, and series.

At present the species of *Pinus* (94 accepted here) are grouped more or less naturally and conveniently into three ranks. The highest rank, the subgenus, contains only three examples of major taxonomic groups, such as the soft pines and hard pines. The second rank, section, has only five examples. For the third rank, subsection with 15 examples clearly has priority over series and much wider usage and is adopted here. Continued use of subsection will result in fewer name changes than adoption of the relatively new rank of series.

Group is rejected as a rank and should not be used with Latin epithets (Art. 4). If a simpler classification of two ranks is desired, the names are subgenus and section. Or, if a simplified classification of several groups in one rank should be desired, the logical name is section. Of course, the names and epithets of the 15 subsections can be used in this way with the generic name or alone, without mention of their subgenera and sections. Otherwise, some epithets of subsections would be changed if the same groups were treated as sections.

The problem is selection of epithets for the 15 taxonomic groups with rank of subsection. The earliest names with rank below section are the 15 taxonomic groups of Loudon (1838) designated by § and "Sect. Char." These epithets have priority, and their type species are indicated by their derivation (Art. 22). Pilger (1926) cited Loudon's names, though some later authors did not. Some of Loudon's epithets derived from those of species were proposed independently by later authors. Several additional names with rank below section are among the subsections, eight designated by § and 14 of lower rank, distinguished by Engelmann (1880).

Thus, the genus *Pinus* may be subdivided into 15 groups of rank subsection, for example, *Pinus* subsect. *Australes*. Table 1 compares the nomenclature adopted here with that of four other classifications of the genus *Pinus*. Names of nine of the 15 subsections are credited to Loudon and two to Engelmann. We have supplied from specific epithets the names needed for the remaining four small subsections, two with only one species each.

SUMMARY OF SUBDIVISIONS OF THE GENUS *PINUS*

The revised nomenclature of the subdivisions of the genus *Pinus* is summarized below. Each accepted name is followed by its citation, basionym if any, type species (holotype or lectotype), pertinent synonyms in use for the same and related ranks including "group" of Shaw and citation by Rehder as series, number and list of included species, with citation, English common name, and geographical distribution of each. Brief descriptions of the taxonomic groups have been adapted and emended from Shaw. Only the main morphological characters are mentioned. Other characters, such as chemistry, have not been included. Latin diagnoses of the subdivisions have been added for completeness, though not required under the Code. Some of these names published long ago have been emended by later authors.

The synonymy is not intended to be complete. It indicates the ranks assigned by later authors to groups published without clear indication of rank. Names of different ranks and circumscriptions have been cited where relevant. Also some synonyms have been

TABLE 1.—Comparison of nomenclature adopted here (left column) with that of other classifications of the genus *Pinus*

Subdivision of genus *Pinus* L.	Duffield (1952)	Rehder (1949)	Shaw (1914, 1924)	Pilger (1926)
Subgen. 1. Ducampopinus (A. Cheval.) de Ferré				
Sect. 1. Ducampopinus				
Subsect. 1. Krempfianae Little & Critchfield			(Group VI)	(Sect. 3, Subsect. 2)
Subgen. 2. Strobus Lemm.	Subgen. Haploxylon	Subgen. I. Strobus	Sect. A. Haploxylon	Subgen. I. Haploxylon
Sect. 2. Strobus		Sect. I. Cembra	Subsect. a. Cembra	
Subsect. 2. Cembrae Loud.		Ser. 1. Cembrae	Group I. Cembrae	Sect. 1. Cembra
3. Strobi Loud.		2. Flexiles	(II. Flexiles)	1. Cembra
		3. Eustrobi	III. Strobi	2. Strobus
Sect. 3. Parrya Mayr		Sect. II. Parrya	Subsect. b. Paracembra	Sect. 3. Paracembra
Subsect. 4. Cembroides Engelm.		Ser. 4. Cembroides	Group IV. Cembroides	Subsect. 1. Gerardianae
5. Gerardianae Loud.		5. Gerardianae	V. Gerardianae	1. Gerardianae
6. Balfourianae Engelm.		6. Balfourianae	VI. Balfourianae	2. Balfourianae
Subgen. 3. Pinus	Subgen. Diploxylon	Subgen. II. Eupitys	Sect. B. Diploxylon	Subgen. II. Diploxylon
Sect. 4. Pinea Endl.			Subsect. c. Parapinaster	
Subsect. 7. Leiophyllae Loud.			Group VII. Leiophyllae	(Sect. 10)
8. Canarienses Loud.			VIII. Longifoliae	Sect. 4. Sula
9. Pineae Little & Critchfield			IX. Pineae	7. Pinea
Sect. 5. Pinus	Subsect. Pinaster	Sect. III. Taeda	Subsect. d. Pinaster	
Subsect. 10. Sylvestres Loud.	Group X. Lariciones	Ser. 7 Sylvestres	Group X. Lariciones	Sect. 5. Eupitys
				9. Khasia
11. Australes Loud.	Group XI	8. Australes	XI. Australes	8. Australes
				11. Taeda
12. Ponderosae Loud.	Group XII	8. Australes	XI. Australes	10. Pseudostrobus
13. Sabinianae Loud.	Group XII	10. Macrocarpae	XIII. Macrocarpae	(Sect. 10, 11)
14. Contortae Little & Critchfield	Group XIII	9. Insignes	XII. Insignes	6. Banksia
15. Oocarpae Little & Critchfield	Group XIV	9. Insignes	XII. Insignes	(Sect. 11)

cited under more than one rank. Additional names were proposed in the references cited above. Names in recent classifications published without Latin diagnoses generally have been omitted.

As defined here, the genus *Pinus* contains three subgenera, five sections (three repeating epithets of subgenera), and 15 subsections. Table 1 compares the nomenclature with the classifications by Duffield (1952), Rehder (1949), Shaw (1914, 1924), and Pilger (1926). Duffield and Rehder did not include the entire genus. Rehder's classification is the same as Shaw's except for slight changes in nomenclature.

Under each subsection are listed in the same order as mapped (Critchfield and Little 1966) the included species with citation, English common name, and brief summary of geographic distribution.

The following key to subdivisions of the genus *Pinus* has been revised and expanded from that of Shaw (1914, p. 25).

348-419—69——3

KEY TO THE SUBDIVISIONS OF THE GENUS *PINUS*

A. Leaves narrowly lanceolate, very flattened (1.5–4 mm. wide), 2 in a fascicle; 1 rare species of Vietnam. Subgen. 1. *Ducampopinus* sect. 1. *Ducampopinus* subsect. 1. *Krempfianae.*

AA. Leaves needlelike, 2–5 (1–8) in a fascicle.

B. Bases of fascicle-bracts not decurrent; leaves with 1 vascular bundle, commonly 5 (5–1) in a fascicle, with deciduous sheath; seeds wingless or winged, if long the wing not detachable. Subgen. 2. *Strobus.*

C. Umbo of cone-scale terminal; leaves 5 in a fascicle. Sect. 2. *Strobus.*

D. Cones indehiscent, deciduous at maturity; seeds wingless. Subsect. 2. *Cembrae.*

DD. Cones dehiscent at maturity; seeds mostly with long wing or with rudimentary wing. Subsect. 3. *Strobi.*

CC. Umbo of cone-scale dorsal; leaves 5–1 in a fascicle. Sect. 3. *Parrya.*

E. Seeds large, wingless or with short wing; leaves 4–1 (rarely 5) in a fascicle, spreading.

F. Seeds wingless; leaves 4–1 (rarely 5) in a fascicle. Subsect. 4. *Cembroides.*

FF. Seeds with short detachable wing; leaves 3 in a fascicle. Subsect. 5. *Gerardianae.*

EE. Seeds small, with long wing; leaves 5 in a fascicle, slightly appressed, persistent many years. Subsect. 6. *Balfourianae.*

BB. Bases of fascicle-bracts decurrent; leaves with 2 vascular bundles, mostly 2 or 3 (sometimes 4–8) in a fascicle, mostly with persistent sheath; seeds mostly with long detachable wing. Subgen. 3. *Pinus.*

G. Seeds with short or long wing, if with long detachable wing the leaves also with deciduous sheath. Sect. 4. *Pinea.*

H. Seeds small, with long detachable wing; leaves with deciduous sheath, 3–5 in a fascicle. Subsect. 7. *Leiophyllae.*

HH. Seeds large, wing otherwise; leaves with persistent sheath.

I. Seeds with long wing not detachable; leaves 3 in a fascicle, long. Subsect. 8. *Canarienses.*

II. Seeds large, with short detachable wing; leaves 2 in a fascicle. Subsect. 9. *Pineae.*

GG. Seeds with long detachable wing; leaves with persistent sheath. Sect. 5. *Pinus.*

J. Cones symmetrical, mostly opening at maturity, shedding or persistent.

K. Cones small to large, cone-scales ending in a prickle or slightly protuberant; seeds with thin base of wing.

L. Spring-shoots mostly with 1 whorl of branches (uninodal).

M. Leaves mostly 2 in a fascicle; cones not leaving basal scales on twig. Subsect. 10. *Sylvestres.*

MM. Leaves 2–5 (8) in a fascicle; cones often leaving a few basal scales on twig. Subsect. 12. *Ponderosae.*

LL. Spring-shoots mostly with 2 or more whorls of branches (multinodal); leaves 2–3 in a fascicle. Subsect. 11. *Australes.*

KK. Cones large, cone-scales very protuberant and ending in long stout point; seeds large, with thick base of wing; leaves 3 or 5 in a fascicle, long. Subsect. 13. *Sabinianae.*

JJ. Cones mostly oblique, mostly remaining closed, long persistent.

N. Leaves 2 in a fascicle, short (2–8 cm. long). Subsect. 14. *Contortae.*

NN. Leaves mostly 3 (2–5) in a fascicle, more than 8 cm. long. Subsect. 15. *Oocarpae.*

Pinus L. pine

Pinus L., Sp. 1000. 1753; Gen. Pl. Ed. 5, 434. 1754; lectotype species: *Pinus sylvestris* L., Sp. Pl. 1000. 1753.

Pinus Tourn., Elem. Bot. 1: 457, t. 355–356. 1694; Inst. Rei Herbar. 1: 585, t. 355–356. 1700.

Pinus [L., emend.] Mill., Gard. Dict. Abridged. Ed. 4, vol. 3. 1754.

Pinus I. *Pinus* Münchhausen, Hausvat. 5: 215. 1770.

Apinus Neck., Elém. Bot. 3: 269. 1790.

Pinus sect. *Peuce* Griseb., Spicil. Fl. Rumel. 2: 347. 1844.

Cembra Opiz, Seznam Rostl. 27. 1852; *nom.*

Strobus Opiz, Lotos [Prag] 4: 94. 1854.

Caryopitys Small, Fl. Southeast. U.S. 29, 1326. 1903.

Leucopitys Nieuwl., Amer. Midland Nat. 3: 69. 1913.

Evergreen resinous trees (rarely shrubs) with branches in whorls, 1 a year (uninodal) or 2 or more multinodal). Buds compound, of many scales. Leaves and shoots or 2 forms, primary leaves on long shoots and usually scalelike, secondary leaves needlelike (rarely narrowly lanceolate) on dwarf shoots in fascicles of usually 2–5 (rarely 1 or 6–8), persistent, with sheaths of bud-scales at base. Monoecious. Male cones clustered, of many scales. Cone ovoid, rounded, or cylindric, symmetrical or oblique, maturing in 2 (rarely 3) years, composed of many spirally arranged thick woody cone-scales, each in the axil of a bract, often enlarged or ending in a pickle or spine. Seeds usually 2 at base of cone-scale, usually long-winged or wingless, edible; cotyledons 4–15 (20–23 in *P. maximartinezii*). About 94 or more species of the northern hemisphere (one crossing the equator in Sumatra), mostly of temperate regions and tropical mountains. Trees of the genus *Pinus* are easily recognized by the unique character among conifers, the needlelike leaves on dwarf shoots in fascicles of usually 2–5 with a sheath of bud scales at base.

Subgen. 1. *Pinus* subgen. *Ducampopinus* (A. Cheval.) de Ferré [2]

Pinus subgen. ***Ducampopinus*** (A. Cheval.) de Ferré ex Critchfield & Little, U.S. Dep. Agr. Misc. Pub. 991: 5. 1966. Holotype species: *Pinus krempfii* Lecomte, Paris Mus. Natl. Hist. Nat. Bull. 27: 191, fig. 1921.

Ducampopinus A. Cheval., Rev. Bot. Appl. d'Agr. Trop. 24: 30. 1944. Holotype species: *Pinus krempfii* Lecomte, *l. c.*

Pinus sous-genre *Ducampopinus* (A. Cheval.) de Ferré, Paris Acad. Sci. Compt. Rend. 236: 228. 1953; not validly published because reference to basionym lacked original publication with page (ICBN Art. 33).

Leaves with 1 vascular bundle, 2 in a fascicle, narrowly lanceolate, very flattened (1.5–4 mm. wide), finely serrulate or entire, with stomata ventral and rarely also dorsal, with resin-ducts subexternal, and sheath early deciduous. Bases of fascicle-bracts not decurrent. Conelet solitary, without prickles. Cones ovoid, symmetrical, opening at maturity. Cone-scales keeled, with thick, pyramidal apophysis and dorsal umbo. Seeds with long detachable wing. Wood medium-hard, slightly resinous, with growth rings, without ray-tracheids, sapwood yellowish white, heartwood salmon. This subgenus differs from the other subgenera in the flattened leaves and in the absence of ray-tracheids. One section, one subsection, and one species of Vietnam.

[2] Folia fasciculo vasculare 1, 2 in fasciculo, anguste lanceolata, valde complanata (1.5–4 mm. late), minute serrulata vel integra, stomatibus ventralibus atque raro dorsalibus, ductis resiniferis subexternis, et vagina mox decidua. Bases bractearum non decurrentes. Strobilus junior solitarius, sine aculeis. Strobili ovoidei, symmetricales, aperti postquam maturi. Squamae carinatae, apophysi crassa pyramidata et umbone dorsali. Semina cum ala longa articulata. Lignum modice durum, leviter resinosum, annulis incrementi, sine tracheidiis radiis, alburno albo luteolo, ligno interiore colore salmonis. A subgeneribus aliis differt foliis complanatis atque absentia tracheidiarum radiis.

Sect. 1. *Pinus* sect. *Ducampopinus*

Pinus subgen. ***Ducampopinus*** sect. ***Ducampopinus***. Holotype species: *Pinus krempfii* Lecomte, *l. c.*

Pinus sect. *Krempfioides* Gaussen, Lab. Forest Toulouse Trav. tome 2, sect. 1. v. 1, pt. 2: 93. 1960; without Latin diagnosis.

With characters of the subgenus. (Characteribus subgeneris.) One species of Vietnam.

Subsect. 1. *Pinus* subsect. *Krempfianae* Little & Critchfield

Pinus sect. ***Ducampopinus*** subsect. ***Krempfianae*** Little & Critchfield, U.S. Dep. Agr. Misc. Pub. 991: 5. 1966; *"Krempfiani"*; holotype (and only) species: *Pinus krempfii* Lecomte, *l. c.*

Pinus sect. *Krempfioides* "groupe Asiatique" *Krempfii* Gaussen, *l. c.* 93. 1960; without Latin diagnosis.

With characters of the subgenus and section. (Characteribus subgeneris et sectionis.) One species of Vietnam: *Pinus krempfii* Lecomte, Paris. Mus. Natl. Hist. Bull. 27: 191, fig. 1921.

Subgen. 2. *Pinus* subgen. *Strobus* Lemm., emend. [3] soft or white pines

Pinus subgen. ***Strobus*** Lemm., Handb. West-Amer. Cone-bearers. Ed. 3, 20. 1895; emend. Holotype species: *Pinus strobus* L., Sp. Pl. 1001. 1753.

Pinus [group] *Strobus* D. Don, Prodr. Fl. Nepal. 54. 1825.

Pinus [group] *Strobus* Sweet, Hort. Brit. ed. 2, 475. 1830. *nom. nud.*

Pinus sect. *Strobus* Sweet ex Spach, Hist. Nat. Végét. Phan. 11: 394. 1842.

Pinus sect. *Peuce* Griseb., Spic. Fl. Rumel. 2: 347. 1844.

Pinus subgen. *Peuce* Griseb. ex Endl., Syn. Conif. 138. 1847; *pro syn.*

Pinus Sekt. *Haploxylon* Koehne, Deut. Dendrol. 28, 1893.

Pinus div. *Tenuisquamae* Masters, Linn. Soc. London J. Bot. 35: 569. 1904.

Pinus subgen. *Haploxylon* Rehd. in Bailey, Cult. Evergr. 302. 1923.

Pinus Untergatt. *Haploxylon* Koehne ex Pilger in Engler & Prantl, Nat. Pflanenfam. Ed. 2, 13: 332. 1926.

[3] Folia fasciculo vasculari 1, plerumque 5 (5–1) in fasciculo, integra vel serrulata, stromatibus dorsalibus aqtue centralibus aut tantum ventralibus, ductis resiniferis plerumque externis, et vagina decidua. Bractearum bases non decurrentes. Ramuli vernales ramulorum verticillo 1 (uninodales). Strobili symmetricales, squamis comparate paucis grandibus, umbone terminali vel dorsali, inermi vel mucronato. Semina aut non alata vel ala rudimentaria separabili vel ala longa articulata. Lignum vulgo lene tantum plus minusve resinosum, annulis incrementi obscuris, comparate pallidum et non grave; radiorum tracheidae parietibus laevibus.

Pinus subgen. *Strobus* (Sweet) Rehd., Bibliog. Cult. Trees Shrubs 32. 1949.

Pinus sous-genre *Haplopinus* Campo-Duplan, Lab. Forest Toulouse Trav. tome 2, sect. 1, v. 4, art. 1: 92. 1950; *nom.*

Pinus subgen. *Malacopitys* Ishii, Kochi Univ. Nat. Sci. Rpts. 2: 112, 124. 1952; without Latin diagnosis.

Pinus sous-genre *Cembrapinus* de Ferré, Paris Acad. Sci. Compt. Rend. 236: 228. 1953.

Pinus sous-genre *Paracembrapinus* de Ferré, Paris Acad. Sci. Compt. Rend. 236: 228. 1953.

Leaves with 1 vascular bundle, commonly 5 (5–1) in a fascicle, entire or serrulate, with stomata dorsal and ventral or ventral only, with resin-ducts mostly external, and with deciduous sheath. Bases of fascicle-bracts not decurrent. Spring-shoot with 1 whorl of branches (uninodal). Cones symmetrical, of relatively few large cone-scales. Umbo of cone-scale terminal or dorsal, unarmed or ending in a prickle. Seeds wingless, or with rudimentary detachable wing, or with long wing usually not detachable. Wood mostly soft and only slightly resinous, with annual rings obscure, relatively light-colored and light-weight, the ray-tracheids with smooth walls.

Two sections, five subsections, and 31 or more species of North America and Eurasia. Long known as *Pinus* subgen. *Haploxylon*.

Apparently the oldest valid name for the soft or white pines with rank of subgenus is *Pinus* subgen. *Strobus* Lemm. The original circumscription corresponded to *Pinus* subgen. *Strobus* sect. *Strobus*, as defined here. The name *Strobus* was credited to Pliny by Pfeiffer (Nomencl. Bot. 2: 1303. 1874).

Sect. 2. *Pinus* sect. Strobus [1]

Pinus subgen. *Strobus* sect. *Strobus* Holotype species: *Pinus strobus* L., Sp. Pl. 1001. 1753.

Pinus sect. *Quinquefoliis* Duhamel, Traité Arbr. Arbust. France 2: 124. 1755. Lectotype species (selected here): *Pinus strobus* L., Sp. Pl. 1001. 1753.

Pinus [group] *Strobus* D. Don, Prodr. Fl. Nepal. 54. 1825.

Pinus [group] *Strobus* Sweet, Hort. Brit. ed 475, 1830; *nom. nud.*

Pinus [group] *Peuce* Sweet, Hort. Brit. ed 2, 475. 1830; *nom. nud.*

Pinus sect. *Quinae* Loud., Arb. Frut. Brit. 4: 2271. 1838. Lectotype species (selected here): *Pinus strobus* L., Sp. Pl. 1001. 1753.

Pinus sect. *Strobus* Sweet ex Spach, Hist. Nat. Végét. Phan. 11: 394. 1842.

Pinus sect. *Cembra* Spach, Hist. Nat. Végét. Phan. 11: 398. 1842.

Pinus sect. *Peuce* Griseb., Spicil. Fl. Rumel. Byth. 2: 347. 1844.

Pinus Sekt. *Haploxylon* Koehne, Deut. Dendrol. 28. 1893.

Pinus subgen. *Haploxylon* sect. *Strobi* Shaw ex Komarov. Fl. URSS. 1: 162. 1934; sektsiia.

Leaves 5 in a fascicle, entire or serrulate, with epidermis and hypodermis distinct and hypodermis uniform. Conelets with scales not ending in point or bristle. Umbo of cone-scale terminal. Wood ray-cells with large pits. This section corresponds to *Pinus* sub sect. *Cembra* of Shaw.

Two subsections, with 19 or more species of mostly northern distribution in North America and Eurasia.

[1] Folia 5, integra vel serrulata, epidermide et hypodermide distincta atque hypodermide uniformi. Strobilorum juvenium squamae non mucronatae; umbone terminali. Radiorum ligneorum cellulae foveis magnis.

Subsect. 2. *Pinus* subsect. *Cembrae* Loud. stone pines

Pinus sect. iii. *Quinae* § xiv. *Cembrae* Loud., Arb. Frut. Brit. 4: 2274. 1838. Holotype species: *Pinus cembra* L., Sp. Pl. 1000. 1753.

Pinus sect. I. *Strobus* § 2 *Cembrae* Engelm., St. Louis Acad. Sci. Trans. 4: 176. 1880.

Pinus Sekt. *Haploxylon* Subsekt. *Cembra* Parl. ex Koehne, Deut. Dendrol. 30. 1893.

Pinus Sekt. *Haploxylon* Subsekt. *Cembra* Gruppe *Eucembra* Koehne, Deut. Dendrol. 30, 31. 1893.

Pinus subgen. *Strobus* group *Alpinae* Lemm., Handb. West-Amer. Cone-bearers ed. 3, 23. 1895.

Pinus sect. *Haploxylon* subsect. *Cembra* Shaw, Genus *Pinus* 25, 26. 1914.

Pinus sect. *Haploxylon* subsect. *Cembra* group I. *Cembrae* Shaw, Genus *Pinus* 25, 26. 1914.

Pinus subgen. *Haploxylon* sect. *Cembra* ser. *Cembrae* Rehd., Man. Cult. Trees Shrubs ed. 2, 37. 1940; without Latin diagnosis.

Pinus subgen. *Strobus* sect. *Cembra* ser. *Cembrae* Engelm. ex Rehd., Bibliog. Cult. Trees Shrubs 32. 1949.

Leaves 5 in a fascicle, serrulate or entire. Cones indehiscent, deciduous at maturity. Seeds wingless. (Folia 5, serrulata vel integra. Strobili indehiscentes, maturitate decidui. Semina non alata.) Five species of northern and high altitude distribution, four in Eurasia and one in North America: *Pinus koraiensis, pumila, sibirica, cembra, albicaulis.*

Eurasia:

Pinus koraiensis Sieb. & Zucc., Fl. Jap. 2: 28, t. 116, fig. 5–6. 1844; exclud. fig. 1–4; Korean pine. Korea to southeastern Siberia and Japan.

Pinus pumila Regel, Index Sem. Hort. Petrop. 1858: 23. 1859; Japanese stone pine. Northeastern Asia from Siberia to Korea and Japan.

Pinus sibirica Du Tour, Nouv. Dict. Hist. Nat. 18: 18. 1803; Siberian stone pine. Western Russia to Siberia and Mongolia.

Pinus cembra L., Sp. Pl. 1000. 1753; Swiss stone pine. Alps and Carpathian Mountains.

North America:

Pinus albicaulis Engelm., Acad. Sci. St. Louis Trans. 2: 209. 1863; whitebark pine. Northwestern United States and western Canada.

Subsect. 3. *Pinus* subsect. *Strobi* Loud. white pines

Pinus sect. iii. *Quinae* § xv. *Strobi* Loud., Arb. Frut. Brit. 4: 2280. 1838. Holotype species: *Pinus strobus* L., Sp. Pl. 1001. 1753.

Pinus sect. I. *Strobus* § 1. *Eustrobi* Engelm., St. Louis Acad. Sci. Trans. 4: 175. 1880.

Pinus Sekt. *Haploxylon* Subsekt. *Cembra* Gruppe *Strobus* Spach ex Koehne, Deut. Dendrol. 30. 1893.

Pinus subgen. *Strobus* group *Elongatae* Lemm., Handb. West-Amer. Cone-bearers ed. 3, 20. 1895.

Pinus sect. *Haploxylon* subsect. *Cembra* group II. *Flexiles* Shaw, Genus *Pinus* 25, 28. 1914.

Pinus sect. *Haploxylon* subsect. *Cembra* group III. *Strobi* Shaw, Genus *Pinus* 25, 30. 1914.

Pinus subgen. *Haploxylon* sect. *Strobi* Shaw ex Komarov, Fl. URSS. 1: 162. 1934; sektsiia.

Pinus subgen. *Haploxylon* sect. *Cembra* ser. *Flexiles* Rehd., Man. Cult. Trees Shrubs ed. 2, 37. 1940; without Latin diagnosis.

Pinus subgen. *Haploxylon* sect. *Cembra* ser. *Strobi* Rehd., Man. Cult. Trees Shrubs ed. 2, 38. 1940; without Latin diagnosis.

Pinus subgen. *Strobus* sect. *Cembra* ser. *Eustrobi* Engelm. ex Rehd., Bibliog. Cult. Trees Shrubs 33. 1949.

Pinus subgen. *Strobus* sect. *Cembra* ser. *Flexiles* Shaw ex Rehd., Bibliog. Cult. Trees Shrubs 33. 1949.

Leaves 5 in a fascicle, serrulate or entire. Cones dehiscent at maturity. Seeds mostly with long detachable wing or with rudimentary wing. (Folia 5, serrulata vel integra. Strobili maturitate dehiscentes. Semina pro patre maxima ala aut longa separabili aut rudimentaria.)

This subsection includes *Pinus* group *Flexiles* Shaw. Afterwards, Shaw (Arnold Arboretum J. 5: 226–227. 1924) united *Pinus* group *Flexiles* with group *Strobi* because he considered the rudimentary seed wing of the former not sufficiently distinct to permit retention of a separate group.

Fourteen species of mostly northern distribution, six in North America and eight in Eurasia: *Pinus strobus, monticola, lambertiana, flexilis, strobiformis, ayacahuite, peuce, armandii, griffithii, dalatensis, parviflora, morrisonicola, fenzeliana, wangii.*

North America:

Pinus strobus L., Sp. Pl. 1001. 1753; eastern white pine. Eastern United States and southeastern Canada, also a variety in southern Mexico and Guatemala.

Pinus monticola Dougl. ex D. Don in Lamb., Descr. Genus *Pinus*, Ed. 3 (8°), vol. 2, unnumbered p. between p. 144 and p. 145. 1832; western white pine. Far Western United States and adjacent Canada.

Pinus lambertiana Dougl., Linn. Soc. London Trans. 15: 500. 1827; sugar pine. Far Western United States and adjacent Baja California.

Pinus flexilis James, Exped. Rocky Mts. 2: 27, 35. 1823; limber pine. Western United States and adjacent Canada.

Pinus strobiformis Engelm. in Wisliz., Mem. Tour. North Mex. 102. 1848; southwestern white pine. Southwestern United States and northern Mexico.

Pinus ayacahuite Ehrenb. in Schlecht., Linnaea 12: 492. 1838; Mexican white pine. Mexico and Central America.

Eurasia:

Pinus peuce Griseb., Spicil. Fl. Rumel. Byth. 2: 349. 1844; Balkan pine. Southeastern Europe.

Pinus armandii Franch., Paris Mus. Hist. Nat. Nouv. Arch., Sér. 2, 7: 95–96, t. 12. 1885; "*armandi*"; Armand pine. China to extreme northeastern India, also Taiwan and Japan.

Pinus griffithii McClelland in Griffith, Notul. Pl. Asiat. 4: 17. 1854; Icon. Pl. As. 4, t. 365, excl. fig. 1–3. 1854; blue pine. Eastern Afghanistan through Himalaya Mountains to southwestern China.

Pinus dalatensis de Ferré, Toulouse Soc. d'Hist. Nat. Bull. 95: 178, figs. 2, 3. 1960. Southern Vietnam.

Pinus parviflora Sieb. & Zucc., Fl. Jap. 2: 27, t. 115. 1844; Japanese white pine. Japan.

Pinus morrisonicola Hayata, Gard. Chron., Ser. 3, 43: 194. 1908; Taiwan white pine. Taiwan.

Pinus fenzeliana Hand.-Mazz., Oesterr. Bot. Ztschr. 80: 337. 1931. Southern China.

Pinus wangii Hu & Cheng, Fan Mem. Inst. Biol. Bull., n. s., 1: 191. 1948. Southeastern Yunnan, China.

Sect. 3. *Pinus* sect. *Parrya* Mayr

Pinus sect. ***Parrya*** Mayr, Wald. Nordamer. 241, 427. 1890. Holotype species: *Pinus parryana* Engelm., Amer. J. Sci. Arts, Ser. 2, 34:332. 1862; (*P. quadrifolia* Parl. ex Sudw.).

Pinus sect. *Balfouria* Mayr, Wald. Nordamer. 354, 428. 1890.

Pinus Sekt. *Haploxylon* Subsekt. *Paracembra* Koehne, Deut. Dendrol. 30. 1893.

Pinus div. *Crassisquamae* sect. *Integrifoliae* Masters, Linn. Soc. London J. Bot. 35: 570. 1904.

Pinus div. *Crassisquamae* sect. *Serratifoliae* Masters, Linn. Soc. London J. Bot. 35: 570. 1904.

Pinus Untergatt. *Haploxylon* Sekt. *Paracembra* Koehne ex Pilger in Engler & Prantl, Natürl. Pflanzenfam. ed. 2, 13: 334. 1926.

Leaves 5–1 in a fascicle, with epidermis and hypodermis similar. Scales of conelets ending in abrupt point or bristle. Umbo of conescale dorsal. Wood ray-cells with small pits. (Folia 5–1, epidermide et hypodermide simili. Strobilorum juvenium squamae mucronatae vel aristatae; umbone dorsali. Radiorum ligneorum cellulae foveolis).

Three subsections, two North American and one Asian, with 12 species. Rehder (1949) adopted for this section the name accepted here, while Shaw (1914) used *Pinus* subsect. *Paracembra* and Pilger (1926) had sect. *Paracembra*.

Subsect. 4. *Pinus* subsect. *Cembroides* Engelm. pinyons or nut pines

Pinus sect. II. ***Pinaster*** § 3. ***Integrifoliae*** subsect. ***Cembroides*** Engelm., St. Louis Acad. Sci. Trans. 4: 176, 178. 1880; "subsection *Cembroides*" on p. 178. Holotype species: *Pinus cembroides* Zucc., K. Bayer. Akad. Wiss. München, Abhandl. Math.-Phys. 1: 392. 1832; Flora [Jena] 15 (2), Beibl. 93. 1832.

Pinus Sekt. *Haploxylon* Subsekt. *Paracembra* Gruppe *Parrya* Mayr ex Koehne, Deut. Dendrol. 32. 1893.

Pinus subgen. *Pinaster* sect. *Terminales* subsect. *Brachyphyllae* Lemm., Handb. West-Amer. Cone-bearers ed. 3, 25. 1895. Lectotype sp. (selected here): *P. edulis* Engelm. in Wisliz., Mem. Tour North. Mex. 88. 1848.

Pinus subgen. *Pinaster* sect. *Terminales* subsect. *Brachyphyllae* group Edules Lemm., Handb. West-Amer. Cone-bearers ed. 3, 26. 1895. Holotype species: *Pinus edulis* Engelm., *l. c.*

Pinus sect. *Edules* Kent in Veitch's Man. Conif. Rev. ed. 308. 1900.

Pinus sect *Haploxylon* subsect. *Paracembra* group IV. *Cembroides* Shaw, Genus *Pinus* 25, 38. 1914.

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Pinus subgen. *Haploxylon* sect. *Paracembra* ser. *Cembroides* Rehd., Man. Cult. Trees Shrubs ed. 2, 39. 1940; without Latin diagnosis.

Pinus subgen. *Strobus* sect. *Parrya* ser. *Cembroides* (Engelm.) Shaw ex Rehd., Bibliog. Cult. Trees Shrubs 34. 1949.

Pinus subgen. *Malacopitys* sect. *Nelsonae* Ishii, Kochi Univ. Nat. Sci. Rpts. 2: 113, 118, 125. 1952; without Latin diagnosis.

Leaves 5–1 in a fascicle, mostly entire, short (2–9 cm. long). Seeds wingless, large. (Folia 5–1, plerumque integra, brevia (2–9 cm. longa). Semina non alata, grandia.) Eight species of dwarf trees and shrubs of semiarid regions of Southwestern United States and Mexico: *Pinus cembroides, edulis, quadrifolia, monophylla, culminicola, maximartinezii, pinceana, nelsonii.*

Incidentally, the epithet subsection *Cembroides* was applied earlier to fossils as *Pinites* B. *Pitys* 5. *Cembroides* Endl. (Synops. Conif. 285. 1847; "subsec. *Cembroides*" Pfeiffer, Nomencl. Bot. 1874).

Pinus cembroides Zucc., K. Bayer. Akad. Wiss, München, Abhandl. Math.-Phys. 1: 392. 1832; Flora [Jena] 15 (2), Beibl. 93. 1832; Mexican pinyon. Mexico and Southwestern United States.

Pinus edulis Engelm. in Wisliz., Mem. Tour. North. Mex. 88. 1848; pinyon. Southwestern United States.

Pinus quadrifolia Parl. ex Sudw., U.S. Dep. Agr. Div. Forestry Bull. 14: 17. 1897; Parry pinyon. Southern California and northern Baja California.

Pinus monophylla Torr. & Frém. in Frém., Rpt. Explor. Exped. Rocky Mts. 319, t. 4. 1845; "*monophyllus*"; singleleaf pinyon. Western United States and Baja California, Mexico.

Pinus culminicola Andresen & Beaman, Arnold Arboretum J. 42: 438, fig. 2–4. 1961; Potosí pinyon. Cerro Potosí, Nuevo León, Mexico.

Pinus maximartinezii Rzedowski, Ciencia 23: 17, fig. 1–3, t. 2. 1964. Martínez pinyon. Zacatecas, Mexico.

Pinus pinceana Gord., Pinet. 204. 1858; Pince pinyon. Northeastern and eastern Mexico.

Pinus nelsonii Shaw, Gard. Chron. Ser. 3, 36: 122, fig. 49. 1904; "*nelsoni*"; Nelson pinyon. Northeastern Mexico.

Excluded name: *Pinus* sect. ii. *Ternatae* § xi. *Llaveanae* Loud., Arb. Frut. Brit. 4: 2267. 1838. Holotype (and only) species: *Pinus llaveana* Otto ex Loud., Arb. Frut. Brit. 4: 2267, figs. 2177–2179. 1838; rejected as based on a mixture consisting of two entirely discordant elements (Art. 70). The cone described and figured does not belong to the subsection above. In publishing the name *Pinus llaveana* Schiede (ex Schlecht., Linnaea 12: 488. 1838) later in the same year, Schlechtendal noted Loudon's error. *Pinus llaveana* Schiede is a synonym of *Pinus cembroides* Zucc.

Subsect. 5. *Pinus* subsect. *Gerardianae* Loud.

Pinus sect. ii. ***Ternatae*** § viii. ***Gerardinae*** Loud., Arb. Frut. Brit. 4: 2254. 1838. Holotype species: *Pinus gerardiana* Wall. ex D. Don in Lamb., Descr. Genus *Pinus*. Ed. 3 (8°), vol. 2, unnumbered p. between p. 144 and 145, t. 79. 1832.

Pinus sect. II. *Pinaster* § 5. *Halepenses* [subsect.] *Gerardianae* Engelm., St. Louis Acad. Sci. Trans. 4: 176. 1880.

Pinus sect. *Haploxylon* subsect. *Paracembra* group V. *Gerardianae* Shaw, Genus *Pinus* 25, 40. 1914.

Pinus Untergatt. *Haploxylon* Sekt. *Paracembra* Untersekt *ardianae* Pilger in Engler & Prantl, Natürl. Pflanzenfa 2, 13: 332. 1926.

Pinus subgen. *Haploxylon* sect. *Paracembra* ser. *Gerard* Rehd., Man. Cult. Trees Shrubs ed. 2, 40. 1940; without diagnosis.

Pinus subgen. *Strobus* sect. *Parrya* ser. *Gerardianae* (Eng Shaw ex Rehd., Bibliog. Cult. Trees Shrubs 35. 1949.

Leaves 3 in a fascicle, serrulate. Seeds large, with shor tachable wing. (Folia 3, serrulata. Semina grandia, ala separabili.) Two species in south and east Asia: *Pinus gerard bungeana.*

Pinus gerardiana Wall. ex D. Don in Lamb., Descr. Genus *P* Ed. 3 (8°), vol. 2, unnumbered p. between p. 144 and 145, t 1832; chilgoza pine. Eastern Afghanistan to northern India.

Pinus bungeana Zucc. in Endl., Synops. Conif. 166. 1847; bark pine. Northern China.

Subsect. 6. *Pinus* subsect. *Balfourianae* Engelm. foxtail pi

Pinus sect. II. ***Pinaster*** § 3. ***Integrifoliae*** [subsect.] *fourianae* Engelm., St. Louis Acad. Sci. Trans. 4: 1880; "*Balfouriana.*" Holotype species: *Pinus balfouri* Grev. & Balf. in A. Murr., Bot. Exped. Oreg. [Rpt. No. No. 618, t. 1853.

Pinus sect. II. *Pinaster* § 3. *Integrifoliae* Engelm., St. L Acad. Sci. Trans. 4: 176. 1880. Lectotype species (selec here): *Pinus balfouriana* Grev. & Balf. in A. Murr., *l. c.*

Pinus sect. *Balfouria* Mayr, Wald. Nordamer. 354, 427. 18

Pinus Sekt. *Haploxylon* Subsekt. *Paracembra* Gruppe *Balfou* Mayr ex Koehne, Deut. Dendrol. 32. 1893.

Pinus subgen. *Pinaster* sect. *Terminales* subsect. *Brachyphyl* group *Plumosae* Lemm., Handb. West-Amer. Cone-bear ed. 3, 26. 1895.

Pinus sect. *Haploxylon* subsect. *Paracembra* group VI. *B fourianae* Shaw, Genus *Pinus* 25, 42. 1914.

Pinus Untergatt. *Haploxylon* Sekt. *Paracembra* Untersekt. *B fourianae* Pilger in Engler & Prantl, Natürl. Pflanzenfam. 2, 13: 332. 1926.

Pinus subgen. *Haploxylon* sect. *Paracembra* ser. *Balfourian* Rehd., Man. Cult. Trees Shrubs ed. 2, 40. 1940; witho Latin diagnosis.

Pinus subgen. *Strobus* sect. *Parrya* ser. *Balfourianae* (Engelm. Shaw ex Rehd., Bibliog. Cult. Trees Shrubs 35. 1949.

Leaves 5 in a fascicle, entire, short (2–4 cm. long), slightl appressed, persistent many years. Seeds with long wing, detachabl or not. (Folia 5, integra, brevia (2–4 cm. longa), parum appressa per annos multos persistentia. Semina ala longa, interdum au numquam separabili.) Two species at high altitudes in Western United States: *Pinus balfouriana, aristata.*

Pinus balfouriana Grev. & Balf. in A. Murr., Bot. Exped. Oreg [Rpt. No. 8] No. 618, t. 1853; foxtail pine. California.

Pinus aristata Engelm. in Parry & Engelm., Amer. J. Sci. an Arts, Ser. 2, 34: 331. 1862; bristlecone pine. Western United States.

Pinus sect. *Pinaster* § 3. *Integrifoliae* Engelm. has not been adopted, as the epithet was not derived from that of a species and as another name of the same date is established in usage.

Subgen. 3. *Pinus* subgen. *Pinus*[5]

hard pines

Pinus subgen. ***Pinus***. Lectotype species: *Pinus sylvestris* L., Sp. Pl. 1000. 1753.

Pinus I. *Pinus* Muenchh., Hausvater 5: 215. 1770.

Pinus [group] *Pinus* Sweet, Hort. Brit. Ed. 2, 475. 1830; *nom. nud.*

Pinus [subgen.] B. *Pinus* Endl., Synops. Conif. 137. 1847.

Pinus subgen. *Pinus* Endl, ex Parl. in DC., Prod. 16 (2): 364, 378. 1868.

Pinus Sekt. *Diploxylon* Koehne, Deut. Dendrol. 30. 1893.

Pinus subgen. *Pinaster* Lemm., Handb. West-Amer. Cone-bearers Ed. 3, 24. 1895.

Pinus div. *Crassisquamae* Masters, Linn. Soc. London J. Bot. 35: 570. 1904.

Pinus subgen. *Diploxylon* Rehd. in Bailey, Cult. Evergr. 311. 1923.

Pinus Untergatt. *Diploxylon* Koehne ex Pilger in Engler & Prantl, Nat. Pflanzenfam. Ed. 2, 13: 336. 1926.

Pinus subgen. *Eupitys* (Spach) Rehd., Bibliog. Cult. Trees 35. 1949.

Pinus sous-genre *Diplopinus* Campo-Duplan, Lab. Forest Toulouse Trav. tome 2, sect. 1, v. 4, art. 1: 94. 1950; *nom.*

Pinus subgen. *Scleropitys* Ishii, Kochi Univ. Nat. Sci. Rpts. 2: 113, 125. 1952; without Latin diagnosis.

Pinus sous-genre *Eupinus* Gaussen, Lab. Forest Toulouse Trav. tome 2. sect. 1, v. 1, pt. 2: 94, 1960; without Latin diagnosis.

Leaves with 2 vascular bundles, mostly 2 or 3 in a fascicle, sometimes 4–8, serrulate, with stomata dorsal and ventral, with resin-ducts mostly medial and internal but in some species (including the type) external, and mostly with persistent sheath. Bases of fascicle-bracts mostly decurrent. Spring-shoots with 1 whorl of branches (uninodal) or 2 or more (multinodal). Cones symmetrical or oblique, of many cone-scales and complex phyllotaxis. Umbo of cone-scale dorsal. Seeds mostly with long detachable wing. Wood hard, resinous, with annual rings distinct, relatively dark colored and heavy, the ray-tracheids with dentate walls.

Two sections, nine subsections, and about 62 or more species of wide distribution in the northern hemisphere, mostly of temperate regions and tropical mountains.

Sect. 4. *Pinus* sect. *Pinea* Endl.[6]

Pinus B. ***Pinus*** sectio XI. ***Pinea*** Endl., Synops. Conif. 182. 1847. Holotype species: *Pinus pinea* L., Sp. Pl. 1000. 1753.

Pinus sect. *Ternatae* Loud., Arb. Frut. Brit. 4: 2236. 1838; *pro parte.*

Pinus sect. *Sula* Mayr, Wald. Nordamer. 428. 1890.

Pinus sect. *Diploxylon* subsect. *Parapinaster* Shaw, Gen. *Pinus* 25, 44. 1914.

Pinus subgen. *Diploxylon* sect. *Parapinaster* Rehd. in Bailey, Cult. Evergr. 311. 1923.

A small heterogeneous section corresponding to *Pinus* subsect. *Parapinaster* Shaw, all species having one of the following characters of *Pinus* subgen. *Strobus* (*Haploxylon*): Leaves with deciduous sheath (subsect. *Leiophyllae*), seeds with short detachable wing (subsect. *Pineae*), or seeds with long wing not detachable (subsect. *Canarienses*). Leaves mostly 3 (2–5) in a fascicle. Spring-shoots with 1 whorl of branches (uninodal). Wood ray-cells with small pits.

Three subsections and five species of mostly southern distribution in North America and Eurasia.

Pinus canariensis and *P. roxburghii* (as *P. longifolia*) of this section were originally included in the 19 species of *Pinus* sect. *Ternatae* Loud., characterized merely by leaves 3 in a sheath. The remaining 17 species are in *Pinus* subgen. *Pinus* sect. *Pinus*. Accordingly, for *Pinus* sect. *Ternatae* Loud. the lectotype selected here is *Pinus taeda* L. (Sp. Pl. 1000. 1753), the first species cited. Thus, Loudon's name is typified for the larger and more representative group of 3-needle pines and is reduced to synonymy under *Pinus* subgen. *Pinus* sect. *Pinus*. The epithet *Ternatae*, though adopted earlier (Critchfield and Little 1966), would be objectionable for a section. It is not a substantive (Rec. 21B) and not derived from the epithet of a specific name, as are all the other epithets of subdivisions in the genus *Pinus* accepted here.

Subsect. 7. *Pinus* subsect. *Leiophyllae* Loud.

Pinus sect. iii. ***Quinae*** § xiii. ***Leiophyllae*** Loud., Arb. Frut. Brit. 2273. 1838. Holotype species: *Pinus leiophylla* Schiede & Deppe in Schlecht. & Cham., Linnaea 6: 354. 1831.

Pinus sect. *Diploxylon* subsect. *Parapinaster* group VII. *Leiophyllae* Shaw, Genus Pinus 25, 44. 1914.

Leaves with deciduous sheath, 3–5 in a fascicle. Seeds small, with long detachable wing. (Folia vagina decidua, 3–5. Semina ala longa separabili.) Two species in Mexico, one of these with a variety extending to Southwestern United States: *Pinus leiophylla* (var. *chihuahuana*), *lumholtzii*.

Pinus leiophylla Schiede & Deppe in Schlecht. & Cham., Linnaea 6: 354. 1831; Chihuahua pine. Mexico and Southwestern United States.

Pinus lumholtzii Robins. & Fern., Amer. Acad. Proc. 30: 122. 1895; Lumholtz pine. Mexico.

Subsect. 8. *Pinus* subsect. *Canarienses* Loud.

Pinus sect. ii. ***Ternatae*** § x. ***Canarienses*** Loud., Arb. Frut. Brit. 4: 2261. 1838. Holotype species: *Pinus canariensis* C. Smith in Buch, Phys. Beschr. Canar. Ins. 159. 1825.

Pinus sect. *Diploxylon* subsect. *Parapinaster* group VIII. *Longifoliae* Shaw, Genus *Pinus* 25, 46. 1914.

Leaves long (20–30 cm.), 3 in a fascicle, with persistent sheath. Seeds large, with long wing not detachable. (Folia longa (20–30 cm.), 3, vagina persistenti. Semina magna, ala longa non articulata.) Designated previously as *Pinus* group *Longifoliae* Shaw. One species in Canary Islands and one in Himalayas: *Pinus canariensis, roxburghii.*

Pinus canariensis C. Smith in Buch, Phys. Beschr. Canar. Ins. 159. 1825; Canary Island pine. Canary Islands.

[5] Folia fasciculis vascularibus 2, plerumque 2 vel 3 in fasciculo, terdum 4–8, serrulata, stomatibus dorsalibus et ventralibus, ductis resiniferis plerumque medialibus et internalibus sed in speciebus aliquis (typo includo) externis, vagina vulgo persistenti. Bractearum bases pro parte maxima decurrentes. Ramuli vernales ramulorum verticillo 1 (uninodales) vel verticillis 2 vel pluribus (mutinodales). Strobili symmetricales vel obliqui, squamis multis, phyllotace complexa, et umbone dorsali. Semina plerumque ala longa separabili. Lignum durum, resinosum, annulis incrementi manifestis, comparate fuscum et grave; radiorum tracheidae parietibus dentatis.

[6] Sectio parva heterogenea *Pino* subsectioni *Parapinasteri* similis cujus species omnes uno characterium sequentium *Pini* subgen. *Strobi* (*Haploxylon*) habent: folia vagina decidua (subsect. Leiophyllae), semina ala brevi separabili (subsect. *Pineae*), vel semina ala longa non articulata (subsect. *Canarienses*). Folia plerumque 3 (2–5). Ramuli vernales ramulorum verticillo 1 (uninodales). Radiorum ligneorum cellulae foveolis.

Pinus roxburghii Sarg., Silva No. Amer. 11: 9. 1897; chir pine. Himalaya Mountains.

Subsect. 9. *Pinus* subsect. *Pineae* Little & Critchfield

Pinus subgen. ***Pinus*** sect. ***Pinea*** Endl. subsect. ***Pineae*** Little & Critchfield, subsect. nov. Holotypus (and only) species: *Pinus pinea* L., Sp. Pl. 1000. 1753.

Pinus B. *Pinus* sectio XI. *Pinea* Endl., Synops. Conif. 182. 1847.

Pinus I. Gruppe *Pinea* Endl. ex K. Koch, Dendrol. 2 (2): 270. 1873.

Pinus sect. *Pinaster* § 1. *Pinea* Eichler in Engler & Prantl, Natürl. Pflanzenfam. II, 1: 71. 1889; *pro parte; nom illegit.* containing type species of genus, *P. sylvestris* L.

Pinus sect. *Diploxylon* subsect. *Parapinaster* group IX. *Pineae* Shaw, Genus *Pinus* 25, 48. 1914.

Pinus Untergatt. *Diploxylon* Sekt. *Pinea* Endl. ex Pilger in Engler & Prantl, Natürl. Pflanzenfam. Ed. 2, 13: 336. 1926.

Pinus subgen. *Scleropitys* sect. *Pineae* Shaw ex Ishii, Kochi Univ. Nat. Sci. Rpts. 2: 114, 118, 125. 1952; without Latin diagnosis.

Pinus subgen. *Pinus* sect. *Ternatae* subsect. *Pineae* Shaw ex Critchfield & Little, U.S. Dep. Agr. Misc. Pub. 991: 11. 1966; *nomen.*

Leaves 2 in a fascicle, with persistent sheath. Seeds large (15-18 mm.) with short detachable wing. (Folia 2 in fasciculo, vagina persistenti; semina grandia (15–18 mm.), ala brevi separabili.) One species in Mediterranean region: *Pinus pinea* L., Sp. Pl. 1000. 1753; Italian stone pine.

Pinus subsect. *Pineae* is published here as a new subsection because no other name is available for the taxonomic group with this circumscription and rank. Shaw (Genus *Pinus* 24. 1914) credited *Pinus* group *Pineae* to Engelmann (St. Louis Acad. Sci. Trans. 175. 1880), who in a key did not give a name to the group containing this single Mediterranean species. *Pinus* group *Pineae* Shaw was published without clear indication of rank (Art. 4, 35). Ishii (Kochi Univ. Nat. Sci. Rpts. 2: 114, 118, 125. 1952) assigned the rank section but without Latin diagnosis. However, *Pinus* sect. *Pineae* Shaw ex Ishii must be treated as a new name because Shaw's rank "group" was within his rank's section and subsection and was not intended to be a section. Shaw's name could not be assigned to a subsection (Art. 35, Note).

Sect. 5. *Pinus* sect. *Pinus* [7]

Pinus subgen. ***Pinus*** sect. ***Pinus.*** Holotype species: *Pinus sylvestris* L., Sp. Pl. 1000. 1753.

Pinus sect. *Bifoliis* Duhamel, Traité Arbr. Arbust. France 2: 124. 1755. Lectotype species (selected here): *Pinus sylvestris* L., Sp. Pl. 1000. 1753.

Pinus sect. *Trifoliis* Duhamel, Traité Arbr. Arbust. France 2: 124. 1755. Lectotype species (selected here): *Pinus palustris* Mill., Gard. Dict. Ed. 8, *Pinus* No. 14. 1768.

Pinus sect. i. *Binae* Loud., Arb. Frut. Brit. 4: 2152. 1838. Lectotype species (selected here): *Pinus sylvestris* L., Sp. Pl. 1000. 1753.

Pinus sect. i. *Binae* § iii. *Pinaster* Loud., Arb. Frut. Brit. 4: 2213. 1838.

Pinus sect. ii. *Ternatae* Loud., Arb. Frut. Brit. 4: 2235. 1 *pro parte.* Lectotype species (selected here): *Pinus taed* Sp. Pl. 1000. 1753.

Pinus sect. *Eupitys* Spach, Nat. Sys. Végét. Phan. 11: 374. 1 Lectotype species (selected here): *Pinus sylvestris* L., Sp 1000. 1753.

Pinus sect. *Taeda* Spach, Hist. Nat. Végét. Phan. 11: 387. 1

Pinus sect. *Pinaster* Koch, Syn. Fl. Germ. Helv. Ed. 2, 2: 1844 (not seen).

Pinus sect. *Pinaster* Endl., Synops. Conif. 166. 1847.

Pinus sect. *Pseudo-strobus* Endl. Synops. Conif. 151. 1847

Pinus sect. *Banksia* Mayr, Wald Nordamer. 107, 426. 189

Pinus subgen. *Pinaster* sect. *Terminales* Lemm., Handb. W Amer. Cone-bearers ed. 3, 25. 1895.

Pinus subgen. *Pinaster* sect. *Laterales* Lemm., Handb. W Amer. Cone-bearers ed. 3, 37. 1895.

Pinus div. *Crassisquamae* sect. *Cubensis* Masters, Linn. S London J. Bot. 35: 570. 1904.

Pinus div. *Crassiquamae* sect. *Filifoliae* Masters, Linn. S London J. Bot. 35: 570. 1904.

Pinus div. *Crassiquamae* sect. *Indicae* Masters, Linn. Soc. L don J. Bot. 35: 570. 1904.

Pinus div. *Crassisquamae* sect. *Ponderosae* Masters, Linn. S London J. Bot. 35: 570. 1904.

Pinus div. *Crassisquamae* sect. *Sylvestres* Masters, Linn. S London J. Bot. 35: 571. 1904.

Pinus sect. *Jeffreya* Mayr, Fremdl. Wald. Parkbäume 364. 19(

Pinus Sekt. *Murraya* Mayr, Fremdl. Wald. Parkbäume 356. 19(

Pinus sect. *Diploxylon* subsect. *Pinaster* (Endl.) Shaw, G *Pinus* 25, 44. 1914.

Pinus Untergatt. *Diploxylon* Sekt. *Australes* (Loud.) Pilger Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 13: 336. 1926.

Pinus subgen. *Diploxylon* sect. *Lariciones* Shaw ex Komaro Fl. URSS. 1: 165. 1934.

Pinus subgen. *Diploxylon* sect. *Insignes* Shaw ex Komarov, F URSS. 1: 165. 1934.

A large group corresponding to *Pinus* subsect. *Pinaster* (Endl Shaw and containing about three-fifths of the species in the genu Leaves mostly 2 or 3, sometimes 4 or 5 (rarely 6–8) in a fascicl with persistent sheath. Spring-shoots with 2 or more whorls c branches (multinodal) or 1 (uninodal). Seeds with long detach able wing, mostly thin (thick and sometimes short in subsec *Sabinianae*). Wood ray-cells mostly with small pits (large in sub sect. *Sylvestres*).

Six subsections and 62 or more species, mostly southern in dis tribution, a few including the type far northern.

Subsect. 10. *Pinus* subsect. *Sylvestres* Loud., emend. [8]

Pinus sect. i. ***Binae*** § i. ***Sylvestres*** Loud., Arb. Frut. Brit. 4: 2152. 1838; emend. Holotype species: *Pinus sylvestris* L., Sp. Pl. 1000. 1753.

Pinus sect. i. *Binae* § ii. *Laricio* Loud., Arb. Frut. Brit. 4: 2200. 1838. Holotype species: *Pinus laricio* Poir., Encycl. Méth. Bot. 4: 399. 1804 (*P. nigra* Arnold).

[7] Folia plerumque 2 vel 3, interdum 4 vel 5 (raro 6–8), vagina persistenti, Ramuli vernales ramulorum verticillis 2 vel pluribus (multinodales) vel 1 (uninodales). Semina ala longa separabili, maximam partem exilia (crassa atque interdum brevia in subsect. *Sabinianis*). Radiorum ligneorum cellulae plerumque foveolis (foveis magnis in subsect. *Sylvestribus*).

[8] Folia pro parte maxima 2, hypodermide uniformi atque ductis resiniferis plerumque externis et medialibus. Ramuli vernales ramulorum verticillo 1 (uninodales). Strobili plerumque symmetricales, maturitate dehiscentes, decidui vel persistentes. Radiorum ligneorum cellulae foveis magnis. Species subsectionis huius a ceteris chromosomatum heterobrachialum paribus 2 vice 1 different.

Pinus sect. i. *Binae* § iii. *Pinaster* Loud., Arb. Frut. Brit. 4: 2213. 1838. Holotype species: *Pinus pinaster* Ait., Hort. Kew. 3: 367. 1789.

Pinus sect. i. *Binae* § iv. *Halepenses* Loud., Arb. Frut. Brit. 4: 2231. 1838. Holotype species: *Pinus halepensis* Mill., Gard. Dict. Ed. 8, *Pinus* No. 8. 1768.

Pinus sect. *Pinea* A. *Pinaster* (Endl.) Parl. in DC., Prodr. 16 (2): 378. 1868.

Pinus sect. II. *Pinaster* § 4. *Sylvestres* Engelm., St. Louis Acad. Sci. Trans. 4: 176. 1880.

Pinus sect. II. *Pinaster* § 6. *Pondersosae* [subsect.] *Lariciones* Engelm., St. Louis Acad. Sci. Trans. 4: 177. 1880.

Pinus Sekt. *Diploxylon* Subsekt. *Pinaster* Mayr ex Koehne, Deut. Dendrol. 34. 1893.

Pinus sect. *Diploxylon* subsect. *Pinaster* group X. *Lariciones* Shaw, Genus *Pinus* 25, 50. 1914.

Pinus subgen. *Diploxylon* sect. *Lariciones* Shaw ex Komarov, Fl. URSS. 1: 165. 1934; sektsiia.

Pinus subgen. *Diploxylon* sect. *Pinaster* ser. *Lariciones* Rehd., Man. Cult. Trees Shrubs ed. 2, 40. 1940; without Latin diagnosis.

Pinus subgen. *Eupitys* sect. *Taeda* ser. *Sylvestres* (Engelm.) Rehd., Bibliog. Cult. Trees Shrubs 35. 1949.

Leaves mostly 2 in a fascicle, with uniform hypodermis and resin-ducts mostly external and medial. Spring-shoots with 1 whorl of branches (uninodal). Cones mostly symmetrical, opening at maturity, shedding or persistent. Wood ray-cells with large pits. The species of this subsection differ from all other pines in having two pairs of heterobrachial chromosomes rather than a single pair (Saylor 1961, 1964).

The largest subsection, corresponding to *Pinus* group *Lariciones* of Shaw. Nineteen or more species, all Old World except *Pinus resinosa* and *P. tropicalis*. Loudon's four subsections of the same date are united here under *Pinus* subsect. *Sylvestres*, the epithet derived from the type species of the genus and thus most appropriate.

Pinus resinosa Ait., Hort. Kew. 3: 367. 1789; red pine. Southeastern Canada and Northeastern United States.

Pinus tropicalis Morelet, Rev. Hort. Côte d'Or 1: 106. 1851; tropical pine. Western Cuba.

Pinus nigra Arnold, Reise Mariazell 8, t. 1785; Austrian pine. Southern Europe, Asia Minor, and local in northwestern Africa.

Pinus heldreichii Christ, Naturf. Gesell. Basel Verhandl. 3: 549. 1863; Heldreich pine. Balkan peninsula and southern Italy.

Pinus mugo Turra, Gior. Ital. (Grisilini) 1: 152. 1764; Swiss mountain pine. Central and southern Europe.

Pinus pinaster Ait., Hort. Kew. 3: 367. 1789; maritime pine. Southwestern Europe and northwestern Africa.

Pinus halepensis Mill., Gard. Dict. ed. 8, *Pinus* No. 8. 1768; Aleppo pine. Southern Europe and northern Africa.

Pinus brutia Ten., Prodr. Fl. Nap. lxxii. 1811. Southeastern Europe and Asia Minor.

Pinus sylvestris L., Sp. Pl. 1000. 1753; Scotch pine. Widespread across Europe and Asia.

Pinus densiflora Sieb. & Zucc., Fl. Jap. 2: 22, t. 112. 1844; Japanese red pine. Japan and adjacent eastern Asia.

Pinus thunbergiana Franco, Lisboa Inst. Super. Agron. An. 16: 130. 1949; Japanese black pine. Japan and Korea.

Pinus massoniana Lamb., Descr. Genus *Pinus* 1: 17, t. 12. 1803; Masson pine. China, northern Vietnam, and Taiwan.

Pinus taiwanensis Hayata, Toyko Col. Sci. J. 30 (Art. 1): 307. 1911; Taiwan red pine. Taiwan.

Pinus luchuensis Mayr, Bot. Centralbl. 58: 149, fig. 1894; Luchu pine. Ryukyu Islands.

Pinus hwangshanensis Hsia in Tsoong, Peiping Nat. Acad. Inst. Bot. Contrib. 4: 155. 1936. Eastern and central China.

Pinus tabulaeformis Carr., Traité Gen. Conif. Ed. 2, 510. 1867; Chinese pine. China to southeastern Tibet, Inner Mongolia, Southern Manchuria, and Shantung.

Pinus yunnanensis Franch., J. de Bot. 13: 253. 1899; Yunnan pine. Southern China in Yunnan and adjacent provinces.

Pinus insularis Endl., Synops. Conif. 157. 1847; Khasi pine. Southeastern Asia and Philippine Islands.

Pinus merkusii Jungh. & de Vriese in de Vriese, Pl. Nov. Ind. Bat. 5, t. 2. 1845; Merkus pine. Southeastern Asia, Sumatra, and Philippine Islands.

Subsect. 11. *Pinus* subsect. *Australes* Loud., emend.* southern yellow pines

Pinus sect. ii. ***Ternatae*** § ix. ***Australes*** Loud., Arb. Frut. Brit. 4: 2255. 1838; emend. Holotype species: *Pinus australis* Michx. f., Hist. Arb. Amér. Sept. 1: 64, t. 6. 1810 (*P. palustris* Mill., Gard. Dict. ed. 8, *Pinus* No. 14. 1768).

Pinus sect. ii. *Ternatae* § v. *Taeda* Loud., Arb. Frut. Brit. 4: 2236. 1838. Holotype species: *Pinus taeda* L., Sp. Pl. 1000. 1753.

Pinus sect. iii. *Quinae* § xii. *Occidentales* Loud., Arb. Frut. Brit. 4: 2271. 1838. Holotype species: *Pinus occidentalis* Sw., Nov. Gen. Sp. Pl. 103. 1788.

Pinus sect. *Pinea* B. *Taeda* (Spach) Parl. in DC., Prodr. 16 (2): 390. 1868.

Pinus sect. II. *Pinaster* § 8. *Australes* Engelm., St. Louis Acad. Sci. Trans. 4: 177. 1880.

Pinus sect. II. *Pinaster* § 7. *Taeda* Engelm., St. Louis Acad. Sci. Trans. 4: 177. 1880.

Pinus Sekt. *Diploxylon* Subsekt. *Taeda* Mayr ex Koehne, Deut. Dendrol. 33: 1893.

Pinus sect. *Diploxylon* subsect. *Pinaster* group XI. *Australes* Shaw, Genus *Pinus* 25, 62. 1914.

Pinus subgen. *Diploxylon* sect. *Pinaster* ser. *Australes* Rehd., Man. Cult. Trees Shrubs. Ed. 2, 44, 1940; without Latin diagnosis.

Pinus subgen. *Eupitys* sect. *Taeda* ser. *Australes* Engelm. ex. Rehd., Bibliog. Cult. Trees Shrubs 39. 1949.

Pinus subgen. *Diploxylon* subsect. *Pinaster* Group XI Duffield, Ztschr. Forstgenet. Forstpflanz. 1: 95: 1952.

Leaves 2–3 in a fascicle, with biform hypodermis, endodermis with thin outer cell walls, and resin-ducts internal or medial. Spring-shoots mostly with 2 or more whorls of branches (multinodal). Cones symmetrical, opening at maturity, shedding without leaving basal scales on twig; cone-scales with prickles mostly persistent.

Eleven species, eight in Southeastern and Eastern United States, two in West Indies, and one in both West Indies and adjacent Central America. *Pinus palustris, taeda, echinata, glabra, rigida, serotina, pungens, elliottii, caribaea, occidentalis, cubensis.*

* Folia 2–3, hypodermide biformi, endodermide parietibus externis exilibus, atque ductis resiniferis aut internalibus aut medialibus. Ramuli vernales plerumque ramulorum verticillis 2 vel pluribus (multinodales). Strobili symmetricales maturitate dehiscentes, decidui sine squamis basalibus in ramulo relictis; squamae mucrone pro parte maxima persistenti.

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The southern yellow pines are Group XI of Duffield (1952) and *Pinus* group *Australes* Shaw in part. Loudon's 3 subsections of the same date are united here under *Pinus* subsect. *Australes* to conserve present usage.

Pinus palustris, Mill., Gard. Dict. ed. 8, *Pinus* No. 14. 1768; longleaf pine. Southeastern United States.

Pinus taeda L., Sp. Pl. 1000. 1753; loblolly pine. Southeastern United States.

Pinus echinata Mill., Gard. Dict. ed. 8, *Pinus* No. 12. 1768; shortleaf pine. Eastern United States.

Pinus glabra Walt., Fl. Carol. 237. 1788; spruce pine. Southeastern United States.

Pinus rigida Mill., Gard. Dict. ed. 8, *Pinus* No. 10. 1768; pitch pine. Eastern United States.

Pinus serotina Michx., Fl. Bor.-Amer. 2: 205. 1803; pond pine. Southeastern United States.

Pinus pungens Lamb., Ann. Bot. 2: 198. 1805; Table-Mountain pine. Eastern United States.

Pinus elliottii Engelm., Acad. Sci. St. Louis Trans. 4: 186, t. 1–3. 1880; slash pine. Southeastern United States.

Pinus caribaea Morelet, Rev. Hort. Côte d'Or 1: 107. 1851; Caribbean pine. Bahama Islands, Cuba, and Central America.

Pinus occidentalis Sw., Nov. Gen. Sp. Pl. 103. 1788; West Indian pine. Hispaniola and Cuba.

Pinus cubensis Griseb., Amer. Acad. Mem., Ser. 2, 8: 530. 1862; Cuban pine. Cuba.

Subsect. 12. *Pinus* subsect. *Ponderosae* Loud., emend.[10]

Pinus sect. ii. ***Ternatae*** § vi. ***Ponderosae*** Loud., Arb. Frut. Brit. 4: 2243. 1838; "*Ponderosa*"; emend. Holotype species: *Pinus ponderosa* Laws., Agr. Man. 354. 1836.

Pinus sect. *Pseudo-strobus* Endl., Synops. Conif. 166. 1847.

Pinus sect. *Pinea* C. *Pseudo-strobus* (Endl.) Parl. in DC., Prodr. 16 (2): 398. 1868.

Pinus sect. II. *Pinaster* § 6. *Ponderosae* Engelm., St. Louis Acad. Sci. Trans. 4: 177. 1880.

Pinus Sekt. *Diploxylon* Subsekt. *Pseudostrobus* Mayr ex Koehne, Deut. Dendrol. 33. 1893.

Pinus subgen. *Pinaster* sect. *Terminales* subsect. *Fracticonae* Lemm., Handb. West-Amer. Cone-bearers ed. 3, 31. 1895. Lectotype sp. (selected here): *Pinus ponderosa* Laws., Agr. Man. 354. 1836.

Pinus subgen. *Diploxylon* subsect. *Pinaster* Group XII Duffield, Ztschr. Forstgenet. Forstpflanz. 1: 95. 1952.

Pinus sect. *Jeffreya* Mayr, Fremdl. Wald. Parkbäume 364. 1906.

Leaves 2–5 (8) in a fascicle, with hypodermis mostly biform or multiform, endodermis mostly with thick outer cell walls, and resin-ducts mostly medial. Spring-shoots mostly with 1 whorl of branches (uninodal). Cones mostly symmetrical, opening at maturity, when shedding often leaving a few basal scales on twig, cone-scales prickly or protuberant.

Thirteen or more species of Western United States (1 extending into Canada), Mexico, and Central America south to Nicaragua: *Pinus ponderosa, washoensis, jeffreyi, engelmannii, durangensis, cooperi, montezumae, hartwegii, michoacana, pseudostrobus, douglasiana, teocote, lawsonii.*

This subsection is removed from *Pinus* group *Australes* Shaw and is that group in part. More than half the species of *Pinus* group *Australes* of Shaw, all those in Western United States, Mexico, and Central America, have been removed and placed in this additional, natural group. This subsection corresponds to Duffield's (1952) Group XII except for the exclusion of the following subsection.

Pinus ponderosa Laws., Agr. Man. 354. 1836; ponderosa pine. Western United States, southwestern Canada and northern Mexico.

Pinus washoensis Mason & Stockwell, Madroño 8: 62. 1945; Washoe pine. Local in California and Nevada.

Pinus jeffreyi Grev. & Balf. in A. Murr., Bot. Exped. Oreg. [pt. No. 8] 2, t. 1853; Jeffrey pine. Southwestern Oregon, California, Western Nevada, and Northern Baja California.

Pinus engelmannii Carr., Rev. Hort., Sér. 4, 3: 227. 1854; "*engelmanni*"; Apache pine. Southwestern United States and northwestern Mexico.

Pinus durangensis Martínez, Mex. Inst. Biol. An. 13: fig. 1942; Durango pine. Mexico.

Pinus cooperi C. E. Blanco, Mex. Inst. Biol. An. 20: 185, fig. 1949; Cooper pine. Northwestern Mexico.

Pinus montezumae Lamb., Descr. Genus Pinus. Ed. 3 (8°), 39, t. 22. 1832; Montezuma pine. Mexico and Guatemala.

Pinus hartwegii Lindl., Bot. Reg. v. 25, Misc. 62. 1839; Hartweg pine. Mexico, Guatemala, and El Salvador.

Pinus michoacana Martínez, Mex. Inst. Biol. An. 15: 1, fig. 1. 1944; Michoacán pine. Central and southern Mexico.

Pinus pseudostrobus Lindl., Bot. Reg. v. 25, Misc. 63. 1839. Mexico to Nicaragua.

Pinus douglasiana Martínez, Madroño 7: 4, t. 1. 1943. Douglas pine. Western Mexico.

Pinus teocote Schiede & Deppe in Schlecht. & Cham., Linnaea 4: 76. 1830. Mexico and Guatemala.

Pinus lawsonii Roezl ex Gord., Pinet. Sup. 64. 1862; Lawson pine. Central and southern Mexico.

Subsect. 13. *Pinus* subsect. *Sabinianae* Loud.[11]

Pinus sect. ii. ***Ternatae*** § vii. ***Sabinianae*** Loud., Arb. Frut. Brit. 4: 2246. 1838. Holotype species: *Pinus sabiniana* Dougl. ex D. Don in Lamb., Descr. genus *Pinus* ed. 3 (8° vol. 2, unnumbered p. between p. 144 and 145, t. 80. 1832.

Pinus group *Sabinea* K. Koch, Dendrologie 2 (2): 312. 1873. "Gruppe."

Pinus subgen. *Pinaster* sect. *Laterales* group *Graves* Lemm., Handb. West-Amer. Cone-bearers ed. 3, 37. 1895.

Pinus sect. *Diploxylon* subsect. *Pinaster* group XII *Macrocarpa* Shaw, Genus *Pinus* 25, 90. 1914.

Pinus subgen. *Diploxylon* sect. *Pinaster* ser. *Macrocarpae* Rehd., Man. Cult. Trees Shrubs ed. 2, 47. 1940; without Latin diagnosis.

[10] Folia 2–5 (8), hypodermide plerumque biformi vel multiformi, endodermide plerumque parietibus externis crassis, atque ductis resiniferis vulgo medialibus. Ramuli vernales plerumque ramulorum verticillo 1 (uninodales). Strobili plerumque symmetricales maturitate dehiscentes, saepe paucis squamis basalibus in ramulo relictis; squamae mucronatae vel protuberantes.

[11] Folia 3 vel 5, longa (15–33 cm.) crassaque, hypodermide crassa multiformi vel biformi, endodermide parietibus externis nunc exilibus nunc crassis, et ductis resiniferis medialibus. Ramuli vernales ramulorum verticillis 2 vel pluribus (multinodales) vel 1 (uninodales). Strobili juveni magni squamis mucronatis. Strobili magni, symmetricales vel leviter obliqui maturitate dehiscentes, persistentes; squamae valde protuberantes acumine longo crasso acri atque curvo vel stricto. Semina magna, ala base crassa.

Pinus subgen. *Eupitys* sect. *Taeda* ser. *Macrocarpae* Shaw ex Rehd., Bibliog. Cult. Trees Shrubs 41. 1949.

Leaves 3 or 5 in a fascicle, long (15–33 cm. long), and stout, with thick multiform or uniform hypodermis, endodermis with both thin and thick outer cell walls, and medial resin-ducts. Spring-shoots with 2 or more whorls of branches (multinodal) or 1 (uninodal). Conelets large, with sharp-pointed scales. Cones large, symmetrical or slightly oblique, opening at maturity, persistent; cone-scales very protuberant and ending in long stout, sharp, curved or straight point. Seeds large, with thick base of wing.

Three species of California, one extending into Baja California, Mexico: *Pinus sabiniana, coulteri, torreyana.* This subsection is the same as *Pinus* group *Macrocarpae* Shaw. However, Duffield (1952) united this group with his Group XII.

Pinus sabiniana Dougl. ex D. Don in Lamb., Descr. Genus *Pinus.* Ed. 3 (8°), vol. 2, unnumbered p. between p. 144 and p. 145, t. 80. 1832; Dougl., Linn. Soc. London Trans. 16: 749. 1833. Digger Pine. California.

Pinus coulteri D. Don, Linn. Soc. London Trans. 17: 440. 1836; Coulter pine. California and northern Baja California.

Pinus torreyana Parry ex Carr., Traité Gen. Conif. 326. 1855; Torrey pine. Local in southern California.

Subsect. 14. *Pinus* subsect. *Contortae* Little & Critchfield [12]

Pinus subgen. ***Pinus*** sect. ***Pinus*** subsect. ***Contortae*** Little & Critchfield, U.S. Dep. Agr. Misc. Pub. 991: 15. 1966. Holotype species: *Pinus contorta* Dougl. ex Loud., Arb. Frut. Brit. 4: 2292, fig. 2210–2211, 1838.

Pinus sect. *Banksia* Mayr, Wald. Nordamer. 107, 426. 1890. Holytype species: *Pinus banksiana* Lamb, Descr. Genus *Pinus* 1: 7, pl. 3. 1803.

Pinus Sekt. *Diploxylon* Subsekt. *Murraya* Mayr ex Koehne, Deut. Dendrol. 33. 1893. Holotype species: *Pinus murrayana* Grev. & Balf. in A. Murr., Bot. Exped. Ore. [Rpt. No. 8] 2, No. 740, t. 1853. (*Pinus contorta* Dougl. ex Loud. var. *murrayana* (Grev. & Balf. in A. Murr.) Engelm. in S. Wats., Bot. Calif. 2: 126. 1879.)

Pinus subgen. *Pinaster* sect. *Terminales* subsect. *Brachyphyllae* group *Parviconae* Lemmon, Handl. West-Amer. Cone-bearers ed. 3, 25. 1895.

Pinus Sekt. *Murraya* Mayr, Fremdl. Wald. Parkbaüme 356. 1906.

Pinus subgen. *Diploxylon* subsect. *Pinaster* Group XIII Duffield, Ztschr. Fortstgenet. Forstpflanz. 1: 95. 1952.

Pinus Untergatt. *Pinus* Sectio *Banksianoides* Jährig, Willdenowia 3: 346. 1962; without Latin diagnosis.

Pinus Untergatt. *Pinus* Sectio *Banksianoides* Gruppe *Banksiana* Jährig, Willdenowia 3: 347. 1962; without Latin diagnosis.

Leaves two in a fascicle, short (2–8 cm. long), with biform hypodermis and mostly medial resin-ducts. Spring-shoots with two or more whorls of branches (multinodal). Cones small (3–8 cm. long), symmetrical or oblique, usually remaining closed and opening late (serotinous), long persistent, the cone-scales mostly with persistent prickle.

Four species, mostly small trees of the United States, one also in Canada, and one in both Canada and Lower California, Mexico: *Pinus banksiana, contorta, virginiana, clausa.*

This new subsection is Duffield's (1952) Group XIII, composed of four similar species which he removed from *Pinus* group *Insignes* Shaw. *Pinus* sect. *Banksia* Mayr was established for a larger group of 11 species including these four. Mayr's name was afterwards changed by its author to *Pinus* sect. *Murraya* Mayr, an illegitimate name substituted for a slightly larger group of 14 species. In the meantime Koehne published *Pinus* subsect. *Murraya* Mayr with 10 species, also illegitimate, including and citing three groups of Engelmann. As apparently no epithet with rank of subsection is available for this small group, we have proposed the new name above. The epithet *Banksia* has not been tranferred from rank of section to this subsection because it is not a plural adjective (Rec. 21B) and because of its larger circumscription.

Pinus banksiana Lamb., Descr. Genus *Pinus* 1: 7, pl. 3, 1803; jack pine. Northeastern United States and nearly across Canada.

Pinus contorta Dougl. ex Loud., Arb. Frut. Brit. 4: 2292, fig. 2210–2211. 1838; lodgepole pine. Western North America from Yukon and southeastern Alaska to northern Baja California.

Pinus virginiana Mill., Gard. Dict. ed. 8, *Pinus* No. 9. 1768; Virginia pine. Eastern United States.

Pinus clausa (Chapm.) Vasey ex Sarg., U.S. Census, 10th, 1880, vol. 9 (Rpt. Forests No. Amer.): 199. 1884; sand pine. Florida and southern Alabama.

Subsect. 15. *Pinus* subsect. *Oocarpae* Little & Critchfield [13]

Pinus subgen. ***Pinus*** subsect. ***Oocarpae*** Little & Critchfield, U.S. Dep. Agr. Misc. Pub. 991: 19. 1966. Holotype species: *Pinus oocarpa* Schiede in Schlecht., Linnaea 12: 491. 1838.

Pinus subgen. *Pinaster* sect. *Laterales* group *Serotinae* Lemm., Handb. West-Amer. Conif. ed. 3, 40. 1895.

Pinus sect. *Diploxylon* subsect. *Pinaster* group XII. *Insignes* Shaw, Genus *Pinus* 25, 76. 1914; *pro parte.*

Pinus subgen. *Diploxylon* sect. *Insignes* Shaw ex Komarov, Fl. URSS. 1: 165. 1934; sektsiia.

Pinus subgen. *Diploxylon* sect. *Pinaster* ser. *Insignes* Rehd., Man. Cult. Trees Shrubs ed. 2, 45. 1940; without Latin diagnosis.

Pinus subgen. *Eupitys* sect. *Taeda* ser. *Insignes* Shaw ex Rehd., Bibliog. Cult. Trees Shrubs 39. 1949.

Pinus subgen. *Diploxylon* subsect. *Pinaster* Group XIV Duffield, Ztschr. Forstgenet. Forstpflanz. 1: 95. 1952.

Pinus subgen. *Sclëropitys* sect. *Radiatae* Ishii, Kochi Univ. Nat. Sci. Rpts. 2: 114, 121, 125. 1952; without Latin diagnosis.

Leaves mostly 3 (2–5) in a fascicle, with hypodermis mostly biform, with resin-ducts mostly medial, sometimes internal or septal. Spring-shoots with 2 or more whorls of branches (multinodal) or 1 (uninodal). Cones mostly oblique, remaining closed, long persistent, cone-scales with prickle or protuberant.

Seven species of Mexico, one of these south to Nicaragua, two others north to California, and one also to both California and Oregon: *Pinus radiata, attenuata, muricata, patula, greggii, oocarpa, pringlei.*

[12] Folia 2, brevia (2–9 cm. longe), hypodermide biforme, ductis resiniferis maxime ex parte medialibus. Ramuli vernales ramulorum verticillis 2 vel pluribus (multinodales). Strobili parvi (3–8 cm. longe), symmetricales vel obliqui, plerumque clausi vel serotini aperti, longe persistentes, squamae plerumque cum aculeo persistente.

[13] Folia plerumque 3 (2–5), hypodermide plerumque biforme, ductis resiniferis maxime ex parte medialibus, interdum internalibus vel septalibus. Ramuli vernales ramulorum verticillis 2 vel pluribus (multinodales) vel 1 (uninodales). Strobili plerumque obliqui, clausi, longe persistentes, squamae cum aculeo vel protuberantes.

This subsection is Duffield's (1952) Group XIV. It contains the seven remaining species of *Pinus* group *Insignes* Shaw after nine species have been removed, four to compose the essentially new subsection *Contortae*, two to subsect. *Sylvestres*, and three to subsect. *Australes*. The group as originally defined to include those species with closed, or serotinous cones, was shown by Duffield to be somewhat artificial.

Pinus group *Insignes* Shaw was assigned the rank of section by Komarov and rank of series by Rehder. This epithet should not be transferred to the rank of subsection because the original circumscription of the group contained the type species of two earlier subsections (Art. 63): *Pinus* sect. i. *Binae* § iii. *Pinaster* Loud., Arb. Frut. Brit. 4: 2213. 1838; *Pinus* sect. i. *Binae* § iv. *Halepenses* Loud., Arb. Frut. Brit. 4: 2231. 1838.

Pinus sect. *Radiatae* Ishii was published without Latin diagnosis for the group with the same circumscription as *Pinus* group *Insignes* Shaw but with 17 species including 1 addition. Thus, this epithet in an illegitimate name (Art. 36, 63, Rec. 72A) should not be adopted here.

Pinus radiata D. Don, Linn. Soc. London Trans. 17: 442. 1836; Monterey pine. Local in central California and Guadalupe Island, Mexico.

Pinus attenuata Lemm., Mining and Sci. Press 64: 45. 1892; knobcone pine. Southwestern Oregon, California, and northern Baja California.

Pinus muricata D. Don, Linn. Soc. London Trans. 17: 441. 1836; bishop pine. California and northern Baja California.

Pinus patula Schiede & Deppe in Schlecht. & Cham., Linnaea 6: 354. 1831; Mexican weeping pine. Eastern Mexico.

Pinus greggii Engelm. ex Parl. in DC., Prodr. 16 (2): 396. 1868; Gregg pine. Northeastern and eastern Mexico.

Pinus oocarpa Schiede in Schlecht., Linnaea 12: 491. 1838. Mexico to Nicaragua.

Pinus pringlei Shaw in Sarg., Trees and Shrubs 1: 211, t. 100. 1905; Pringle pine. Central and southern Mexico.

DISTRIBUTION OF SPECIES OF *PINUS*

Table 2 summarizes the geographic and taxonomic distribution of the 94 species mapped by Critchfield and Little (1966). The totals may be compared with the briefer compilation of 66 species in Shaw's (1914, p. 24) conservative monograph of a half century ago and with the 103 species recognized by Mirov (1967).

Naturally agreement is lacking on the exact number of species in this large, widely distributed genus. Several species united by Shaw are now generally accepted as distinct, while several very different species have been discovered afterwards. Also, perhaps in time the species concept in *Pinus* may have become slightly narrower. For example, Gaussen (1960) accepted 120 species. Further study of several recently named species in less accessible regions would be desirable for verification of their validity. Careful examination of a widespread species often reveals additional geographic variations worthy of recognition though usually at an infraspecific rank rather than specific.

The top line of table 2 shows total number of species of *Pinus* in major geographic and political regions including larger countries and islands. The 94 species are distributed 59 in the New World or North America in the broad sense (including Central America and West Indies) and 35 in the Old World. P is native in both the Old and New World.

The 59 species of the New World may be grouped t follows:

Alaska one, also to Canada and Mexico.

Canada nine, all nine also in United States (including t in Mexico and one of those also with a variety in Central A

United States 36, including Western United States 23 a ern United States 13.

Western United States and also Canada five (including in Mexico).

Eastern United States and also Canada four (including with a variety in Mexico and Central America).

United States and also Mexico 16 (including one also ir America).

Mexico 35, including 15 also in Western United States also in Eastern United States.

Mexico 35, including 10 in Baja California (one on Gu Island only) and 26 in the rest of Mexico.

Baja California 10 (1 on Guadalupe Island only), all 1(Western United States (including 9 also in California, 1 also in Canada and Alaska, but only one also elsewhere in M

Central America 8, including 6 also in Mexico (1 of th in Eastern United States and Canada) and one also in West

West Indies four, including one also in Central America.

There are several concentrations of many species of *Pin* region of western North America including Mexico and America has 44 species in 10 subsections. Mexico has 35 spec according to Martínez, 1945), more than any other area o size, and about as many as the United States, though con only one-fifth of the area of contiguous or conterminous States.

California has 19 of the 23 species of *Pinus* in Western States, probably the greatest concentration in the genus. Nc Baja California perhaps should be included, as nine of the 19 southward beyond the artificial, political boundary. Three (*P. balfouriana, P. sabiniana,* and *P. torreyana*) are ende California. Eight others have most of their range within Cali Four of these (*P. quadrifolia, P. coulteri, P. radiata, P. mur* are restricted to California and northern Baja California (*P. r* on Guadalupe Island only), while one (*P. attenuata*) extend to western Oregon and two others (*P. lambertiana, P. jef* also to western Oregon and western Nevada. Anothe *washoensis*) is local in California and western Nevada.

The 35 Old World species of *Pinus* include 34 in Eurasia also in northern Africa) and one confined to Canary Islan Africa. The 34 of Eurasia may be grouped into western Euro and Asia 27 (including three also in Western Europe). Afric four species (including three also in Eurasia and one confin Canary Islands). Mainland China has 14 species, Soviet Unio and India 5.

In eastern and southeastern Asia from China and Japan s ward, including islands, are found 21 of the 27 species of *I* in Asia. Mainland China has 14. Southeastern Asia (exclu islands) has five including three not also in China. Korea has Japan six, Taiwan four, Philippines two, and Sumatra one. Asiatic species are limited to islands from Japan to Taiwan not known from the continent.

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TABLE 2.—Geographic and taxonomic distribution of the 94 species of *Pinus*, based on Critchfield and Little (1966). Totals in subgenera and sections are in parentheses. The top line summarizes totals in major geographic and political regions, while vertical columns show distribution by taxonomic subdivisions. Many species are in more than 1 column. Species under islands are counted also under adjacent continent except column of southeast Asia

Taxonomic group	World	New World	Canada	United States	Western United States	Eastern United States	Mexico	Mexico (excluding Baja California)	Baja California	Central America	West Indies	Old World	Canary Islands	Africa	Eurasia	Western Europe	U.S.S.R.	Mediterranean Region	Asia	Asia Minor	India	China (mainland)	Japan	Southeast Asia (excluding islands)	Taiwan	Philippines	Sumatra
Pinus	94	59	9	36	23	13	35	26	10	8	4	35	1	4	34	10	6	5	27	5	5	14	6	5	4	2	1
Subgen. 1. Ducampopinus	(1)	....	....	....	....	....	....	....	....	....	....	(1)	....	....	(1)	....	....	....	(1)	....	....	....	....	(1)	....	....	....
Sect. 1. Ducampopinus	(1)	....	....	....	....	....	....	....	....	....	....	(1)	....	....	(1)	....	....	....	(1)	....	....	....	....	(1)	....	....	....
Subsect. 1. Krempfianae	1	....	....	....	....	....	....	....	....	....	....	1	....	....	1	....	....	....	1	....	....	....	....	1	....	....	....
Subgen. 2. Strobus	(31)	(17)	(4)	(12)	(11)	(1)	(12)	(9)	(4)	(2)	....	(14)	....	....	(14)	(2)	(3)	....	(12)	....	(3)	(7)	(4)	(1)	(2)	....	....
Sect. 2. Strobus	(19)	(7)	(4)	(6)	(5)	(1)	(4)	(3)	(4)	(2)	....	(12)	....	....	(12)	(2)	(3)	....	(10)	....	(2)	(6)	(4)	(1)	(2)	....	....
Subsect. 2. Cembrae	5	1	1	1	1	....	....	....	....	....	....	4	....	....	4	1	3	....	3	....	....	2	2	....	....	....	....
3. Strobi	14	6	3	5	4	1	4	3	1	2	....	8	....	....	8	1	....	....	7	....	2	4	2	1	2	....	....
Sect. 3. Parrya	(12)	(10)	....	(6)	(6)	....	(8)	(6)	(3)	....	....	(2)	....	....	(2)	....	....	....	(2)	....	(1)	(1)	....	....	....	....	....
Subsect. 4. Cembroides	8	8	....	4	4	....	8	6	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5. Gerardianae	2	....	....	....	....	....	....	....	....	....	....	2	....	....	2	....	....	....	2	....	1	1	....	....	....	....	....
6. Balfourianae	2	2	....	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Subgen. 3. Pinus	(62)	(42)	(5)	(24)	(12)	(12)	(23)	(17)	(6)	(6)	(4)	(20)	(1)	(4)	(19)	(8)	(3)	(5)	(14)	(5)	(2)	(7)	(2)	(3)	(2)	(2)	(1)
Sect. 4. Pinea	(5)	(2)	....	(1)	(1)	....	(2)	(2)	....	....	....	(3)	(1)	(1)	(2)	(1)	....	(1)	(1)	(1)	(1)	....	....	....	....	....	....
Subsect. 7. Leiophyllae	2	2	....	1	1	....	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
8. Canarienses	2	....	....	....	....	....	....	....	....	....	....	2	1	1	1	....	....	....	1	....	1	....	....	....	....	....	....
9. Pineae	1	....	....	....	....	....	....	....	....	....	....	1	....	....	1	1	....	1	....	1	....	....	....	....	....	....	....
Sect. 5. Pinus	(57)	(40)	(5)	(23)	(11)	(12)	(21)	(15)	(6)	(6)	(4)	(17)	....	(3)	(17)	(7)	(3)	(4)	(13)	(4)	(1)	(7)	(2)	(3)	(2)	(2)	(1)
Subsect. 10. Sylvestres	19	2	1	1	....	1	....	....	....	....	1	17	....	3	17	7	3	4	13	4	1	7	2	3	2	2	1
11. Australes	11	11	1	8	....	8	....	....	....	1	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12. Ponderosae	13	13	1	4	4	....	12	11	1	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13. Sabinianae	3	3	....	3	3	....	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14. Contortae	4	4	2	4	1	3	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15. Oocarpae	7	7	....	3	3	....	7	4	3	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

MAPS OF GEOGRAPHIC DISTRIBUTION OF SUBDIVISIONS

The geographic distribution of the genus *Pinus* and its subdivisions is presented graphically and summarized on 22 maps, eight of the world (maps 1–8) and 14 of North America (maps 9–22). These maps listed under Contents and in the List of Maps have been combined without revision from our 63 maps of the 94 species (Critchfield and Little 1966). Included are maps of the genus, each subgenus, and each subsection, both in the world and North America. However, the eight subsections confined to North America are shown only on North American maps. The five sections have not been mapped separately.

The maps were copied by pencil directly from 63 original maps. A projector in a dark room was used to copy and combine the species maps on the two smaller base maps of North America and the world. Then the maps of the subsections were further combined by tracing on a light table. These pencil maps have been reproduced here as halftones made with a very fine screen. Thus, time-consuming redrafting, with possible loss of detail and accuracy, was avoided.

Map 1 outlines the detailed natural distribution of the genus *Pinus* throughout the world and summarizes the maximum ranges of all 94 species combined. The earlier map of the genus *Pinus* (Critchfield and Little 1966, map 1), had a different projection, viewed from the North Pole.

The genus *Pinus* (maps 1 and 9) is widespread across North America and Eurasia and extends to northern Africa and to adjacent islands of these continents. It is mainly north temperate but crosses the Tropic of Cancer into the tropics southward mostly in mountains in Mexico, Central America, West Indies, and southeastern Asia to the Philippines and Sumatra. One species (*Pinus merkusii*) crosses the Equator to 2° S. latitude. Three species cross the Arctic Circle in Eurasia, and two of these extend beyond 70° N. latitude.

Map 9 shows the natural distribution of the genus *Pinus* in North America, or the New World, and summarizes the maximum ranges of all 59 species. *Pinus* is the most widespread genus of trees in North America. It extends from Newfoundland across Canada to southeastern Alaska, south in Western United States through mountains of Mexico and Central America to Nicaragua (three species), also to Baja California and Guadalupe Island, and through Eastern United States to the Bahamas, Cuba, and Hispaniola. Its latitudinal range is more than 53° from 65° N. in northwestern Canada to 12° N. in Nicaragua. The large area across Canada is occupied mostly by two species, *P. banksiana* and in the Far West and southeastern Alaska *P. contorta*.

The genus *Pinus* is native in 48 States of the United States, all on the continent, including Alaska, with the exception of Kansas. It is planted also but not native in Hawaii and the Commonwealth of Puerto Rico. *P. echinata* was reported many years ago from Kansas (Britton and Shafer, No. Amer. Trees 32. 1908), but the late Frank C. Gates did not find it in a careful search.[14]

Mention should be made of the first map of the genus *Pinus* in North America, published 85 years earlier by Sargent (1884). That map indicated approximate limits of the genus, as well as numbers of species. The southeastern corner of Kansas was shown within the range.

[14] Correspondence with senior author.

The distribution of the two main subgenera of *Pinus* (maps 2, 3, 10, 11) has been mapped and summarized by Florin (1963, pp. 252–256). These new maps show in greater detail the limits and the discontinuous portions observed by him. For example, *Pinus* is absent from interior Alaska, interior United States, northeastern Canada, and large areas of central Eurasia. As noted by Florin, the range of *Pinus* subgen. *Strobus* is less than that of subgen. *Pinus* except in northern and northeastern Asia. *Pinus* subgen. *Ducampopinus* is represented by one anomalous species (*Pinus krempfii*) confined to Vietnam (map 2).

The hard pines comprising *Pinus* subgen. *Pinus* reach the extreme limits of the genus except in northern and northeastern Asia. They extend farthest south, to Nicaragua in the New World, to northern Africa, and below the equator to Sumatra. Also, hard pines are the only pines in islands along the southern border of the generic range, for example, in the West Indies, Canary Islands, Sumatra, and Philippines. The presence of pines on these oceanic islands is evidence of migration across water and suggests that some distribution on land may also have been discontinuous. The soft pines forming *Pinus* subgen. *Strobus* occupy mostly cool regions, especially northern latitudes, but extend southward in mountains, including the Cordilleras of Mexico and Central America, the Alps, and Himalayas.

In North America the 42 species of hard pines forming *Pinus* subgen. *Pinus* are more extensive than the 17 species of soft pines composing *Pinus* subgen. *Strobus* (maps 10, 11). The former, occupying the northern and southern limits, are the only pines in the West Indies and are represented in all States except Kansas, Iowa, and Hawaii. The soft pines have a single species (*Pinus strobus*) in Eastern North America but are native in all States except nine: Alaska, Kansas, Missouri, Arkansas, Louisiana, Mississippi, Alabama, Florida, and Hawaii.

The maps of the 15 subsections (maps 4–8, 12–22) show mostly compact or continuous ranges, perhaps more natural than ranges of corresponding groups of older classifications. Eight subsections are confined to North America and four to the Old World, while only three are found in both.

The three subsections represented in both New and Old World are of special interest. *Pinus* subsect. *Cembrae*, with indehiscent cone regarded as primitive, has circumboreal distribution in cold temperate regions (maps 4, 12). Its five species include one at high altitudes in northwestern North America, one in the Alps and Carpathian Mountains, two in northern Asia, and one from Korea and eastern Manchuria to Japan.

Pinus subsect. *Strobi*, the most closely related subsection, is also in both New and Old World but extends southward in less cold regions, especially mountains (maps 5, 13). It contains 14 species, six New World and eight Old World, almost half of the 31 species of the subgenus of soft pines. The New World species extend farthest north, to southern Canada, and south mostly in mountains to Mexico, Central America, and Appalachian Mountains. Old World species are scattered mostly in mountainous parts of southeastern Europe, the Himalayas, mainland China, Vietnam, Taiwan, and Japan.

Pinus subsect. *Sylvestres*, the largest subsection in number of species, is the only one of nine subsections of hard pines found in both the New and Old World (maps 8, 17). However, only two of the 19 species are found in the New World. This large subsection

contains 17 of the 20 hard pine species and almost half of the 35 pine species in the Old World. The species are widespread from northern Africa across Eurasia to Japan. The two New World species are both eastern, one northeastern, and one in Cuba. Cytological studies by Saylor (1961, 1964) confirmed that this is a natural group distinguished from all other species of the genus by the two pairs of heterobrachial chromosomes rather than one pair.

The four subsections confined to the Old World have a total of only six species. *Pinus* subsect. *Gerardianae* contains one species in the Himalayas and nearby mountains and one rare and scattered in mountains of northern China, separated by 1,300 miles of Tibetan highland (map 6). *Pinus* subsect. *Canarienses* has one species in the Canary Islands, off the coast of northwestern Africa, and one in the Himalaya Mountains more than 5,000 miles away (map 7).

Eight subsections with a total of 50 species are limited to the New World. The two subsections of soft pines occupy distinct altitudinal zones. *Pinus* subsect. *Balfourianae* has two timberline species scattered at high altitudes in the Western United States (map 15). *Pinus* subsect. *Cembroides* comprises the pinyons or nut pines, eight species of dwarf trees and shrubs of semiarid regions of low altitudes in Southwestern United States and Mexico, one of these up to timberline (map 14).

One of the five New World subsections of hard pines is eastern. *Pinus* subsect. *Australes* as remodeled is a natural group of 11 species, eight in the Eastern and Southeastern United States, including the southern yellow pines, two in West Indies, and one in both West Indies and Central America (map 18).

Pinus subsect. *Ponderosae* with 13 species is the largest New World subsection (map 19). It extends from southwestern Canada through the Western United States (mostly one species, *Pinus ponderosa*) and Mexico south to Nicaragua. Also, most of the hard pines of Mexico belong here.

Pinus subsect. *Leiophyllae* has two Mexican species, one also in Southwestern United States (map 16). *Pinus* subsect. *Oocarpae* has seven species mostly Mexican, but it extends north along the Pacific coast to California and Oregon and south to Nicaragua (map 22).

Pinus subsect. *Sabinianae* has the smallest range of any New World subsection (map 20). It has three species in California, one extending into Baja California, Mexico.

Pinus subsect. *Contortae* is composed of four species of mostly small trees of mostly separate range around North America, one in Florida, one in Eastern United States, one nearly across Canada, and one western south to Baja California.

APPLICATIONS OF THE MAPS

These maps of subdivisions of the genus *Pinus* may have further applications as suggested, for example, in researches on classification, present and past distribution, tree breeding, and introduction.

There is a relatively close correlation between the latest classification of the genus and the geographic distribution of the subdivisions of the genus *Pinus*. In general the closely related species are grouped in nearby regions. Further improvements in the classification may lead to refinement in the maps of the subdivisions. To the extent that the classification may be artificial, the maps will be affected.

These maps confirm several familiar patterns of plant distribution and evolution. The genus *Pinus* is north temperate with minor range extensions of some subdivisions southward into the tropics, mostly on mountains. It apparently originated in the north temperate zone. Subsections of broad range may be older than those of local range. The ranges of some subsections now discontinuous may have been continuous in the past, or more nearly so. These subsections of interrupted distribution may be relatively old. However, the common occurrence on islands confirms that some discontinuous range may be normal.

The three subsections with representatives in both the Old and New World apparently are older and more primitive than most of the remaining 12 sections.

Six subsections with 35 species are restricted to the region of Western North America including Mexico and Central America. It may be assumed that these six subsections and their species evolved here, in the absence of fossil evidence to the contrary. Speciation in this region may have been accelerated by the highly variable and changing conditions of altitude, climate, and soil. The subsections regarded as more specialized or advanced generally occupy small areas within this region and may be relatively young in origin. Examples are *Pinus* subsect. *Cembroides*, subsect. *Sabinianae*, and subsect. *Oocarpae*.

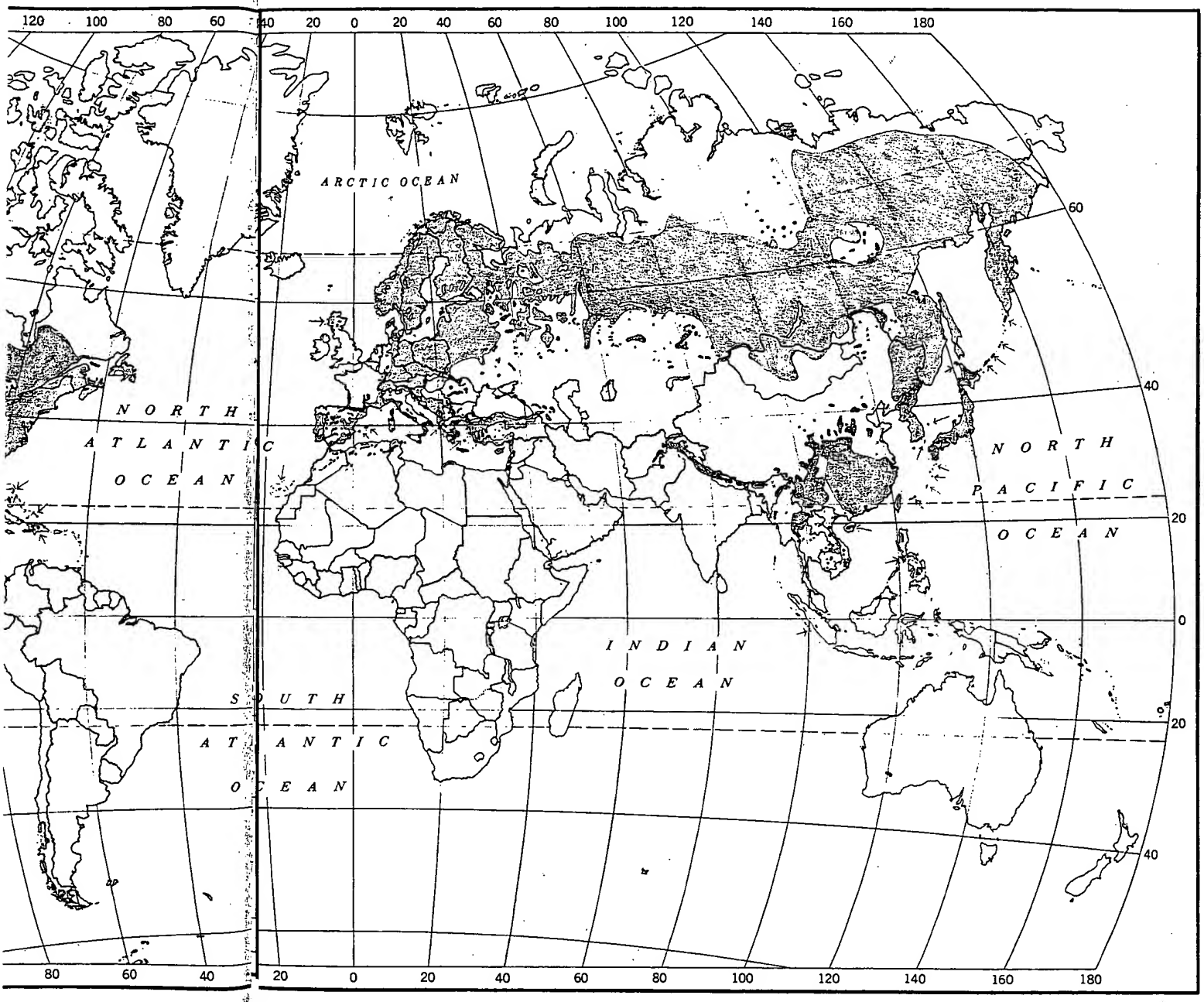
Florin (1963, pp. 252–256) has reviewed and mapped the present and past distribution of the subgenera of the genus *Pinus*. However, he did not consider subdivisions of lower rank because of the difficulty of classifying fossil remains correspondingly. As more information about fossil pines becomes available, perhaps further comparison can be made with the maps of subsections in studies of evolution within the genus. Fossil records should contribute to better interpretation of the present maps, such as in connecting discontinuous parts and in confirming routes and periods of migration.

Florin noted that large scale fluctuations in distribution have occurred as a consequence of changes in the relation of land and sea, in topography, and in climatic conditions since early Cretaceous times, the age of the oldest known fossil remains of *Pinus* subgen. *Pinus*. Very few fossil records are outside present areas of distribution, but *Pinus* subgen. *Strobus* was more widespread in Europe in the Tertiary than now. Florin stated that the extension of *Pinus* subgen. *Pinus* into Central America probably dates from the middle to late Tertiary, and its present configuration in the West Indian, Mediterranean, and Malaysian regions from Pleistocene times.

The maps of subsections may suggest possible areas of geographic races or provenances in selecting pines for introduction to other parts of the world with similar climates. As related species of the same subsection have similar properties, additional geographic sources may be indicated.

There may be applications in tree breeding programs also. In general, artificial hybridization is likely to be more successful between closely related species of the same subsection than between those of different subsections. Each map of a subsection summarizes the geographic distribution of related species within which crossing might be possible. Thus, the maps may suggest localities as sources of germ plasm for hybridization for regions with similar climates elsewhere.

Map 1. The genus *Pinus* (94 species).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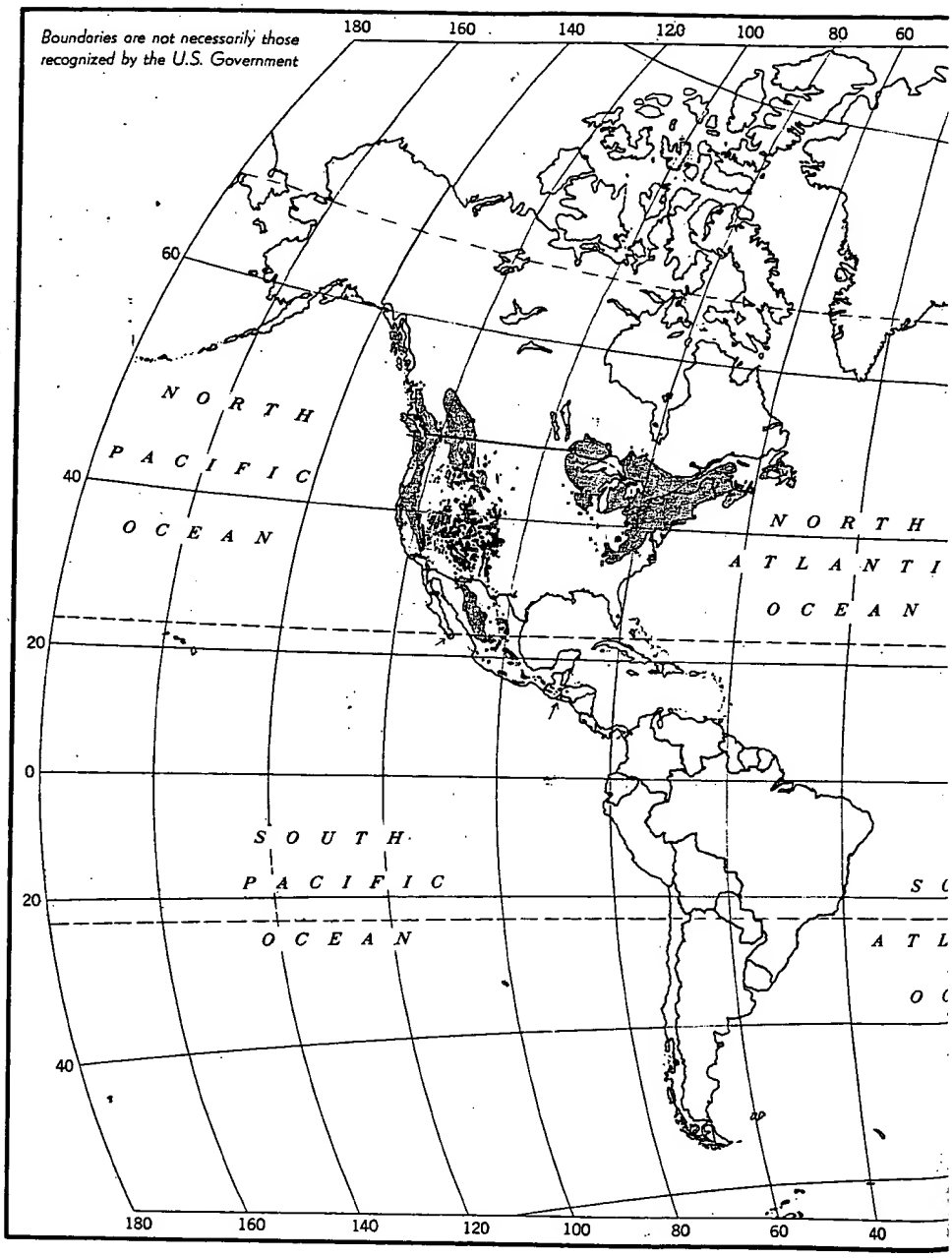
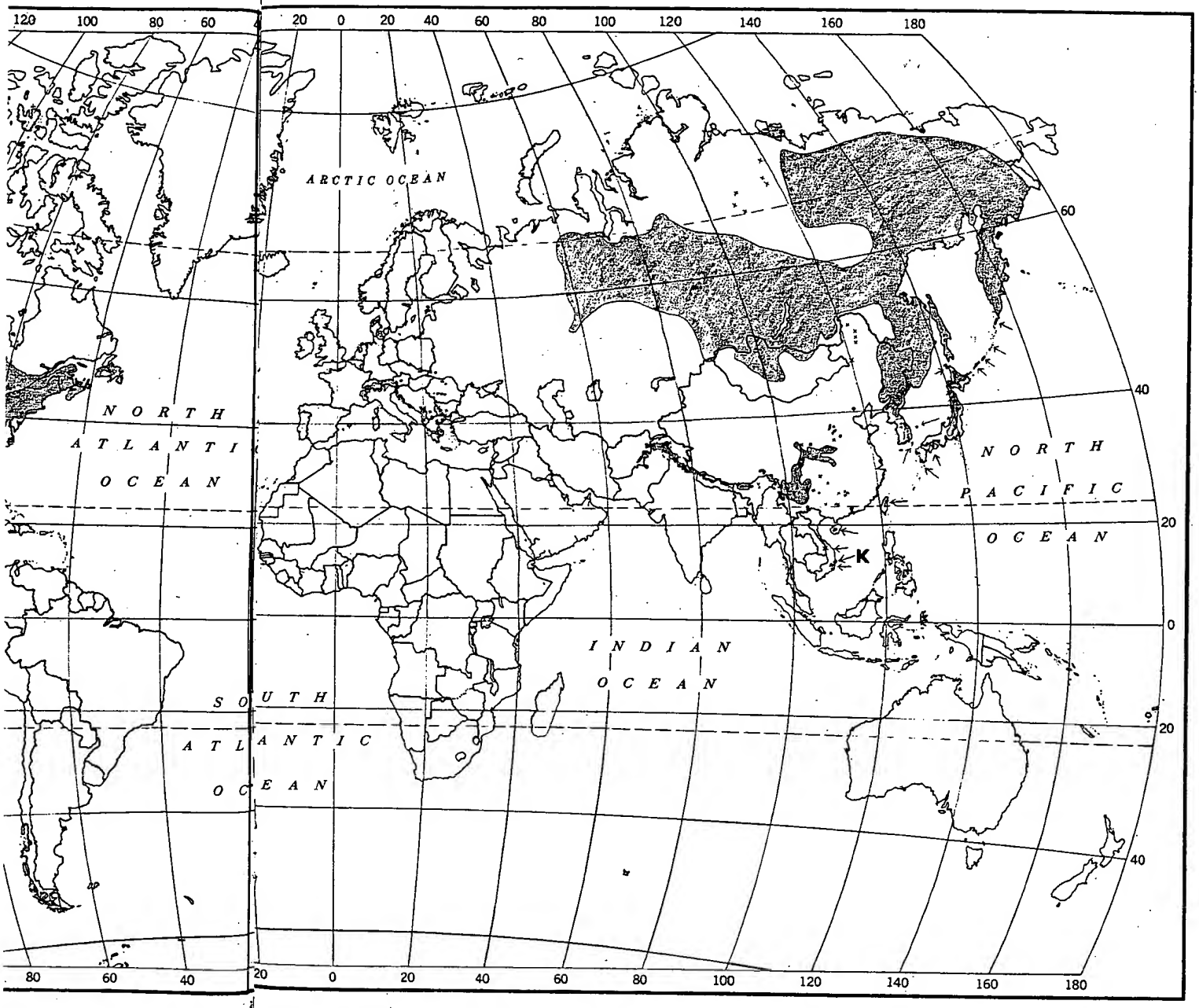


Map 2. ***Pinus*** **subgen.** ***Strobus*** **(31 species) and subgen.** ***Ducampopinus*** **(1 species,** ***P. krempfii,*** **K.).**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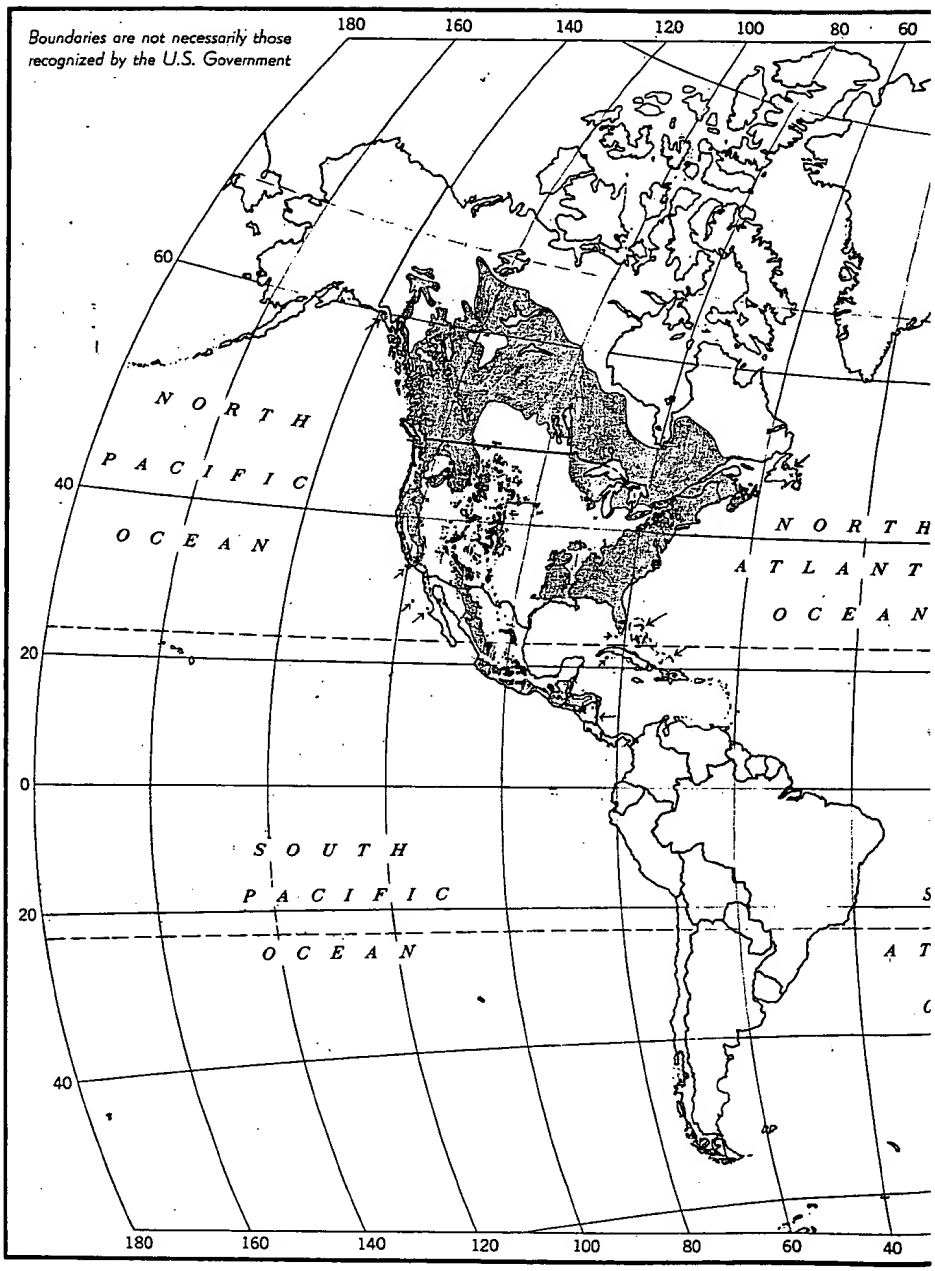
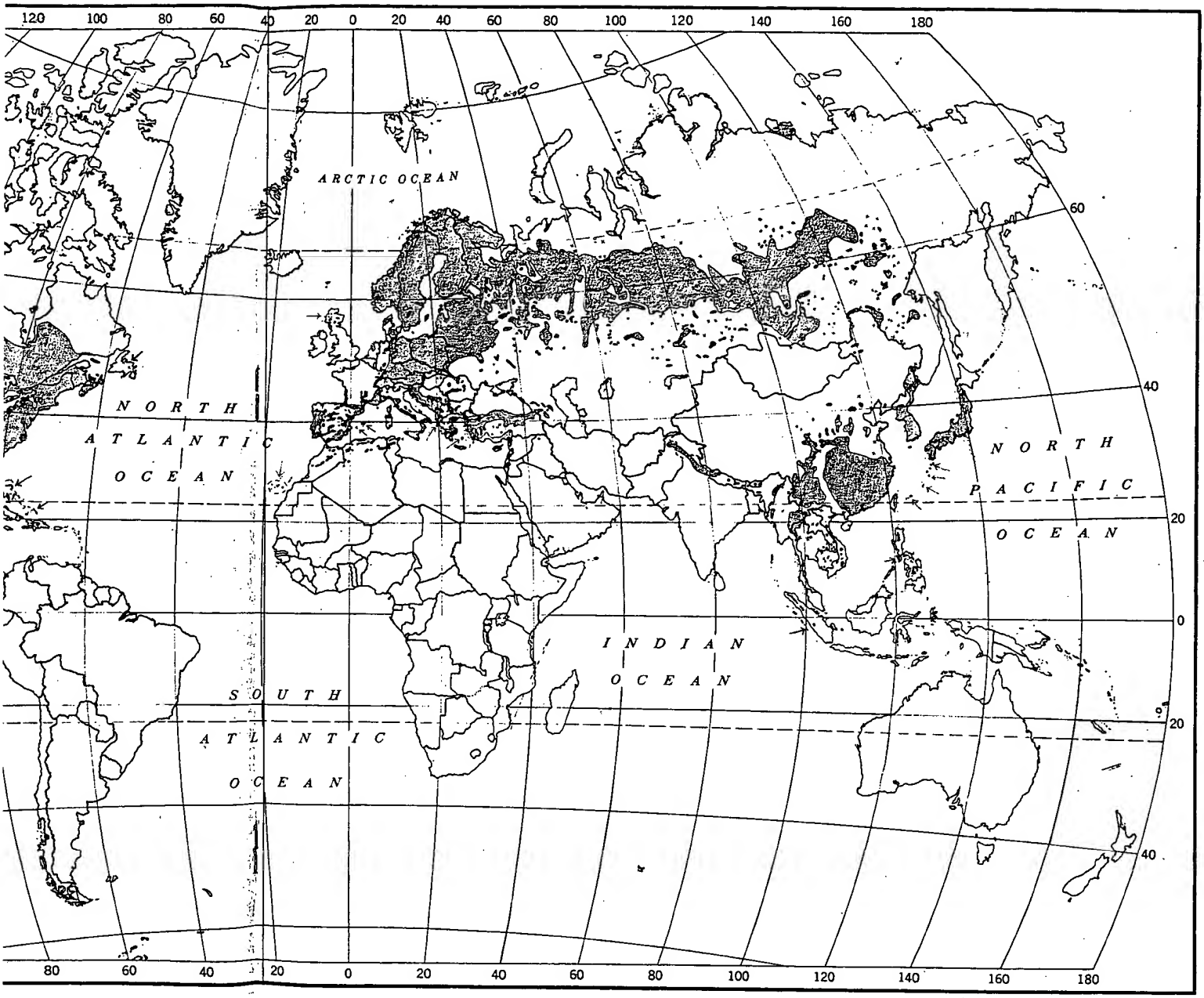


Map 3. *Pinus* subgen. *Pinus* (62 species).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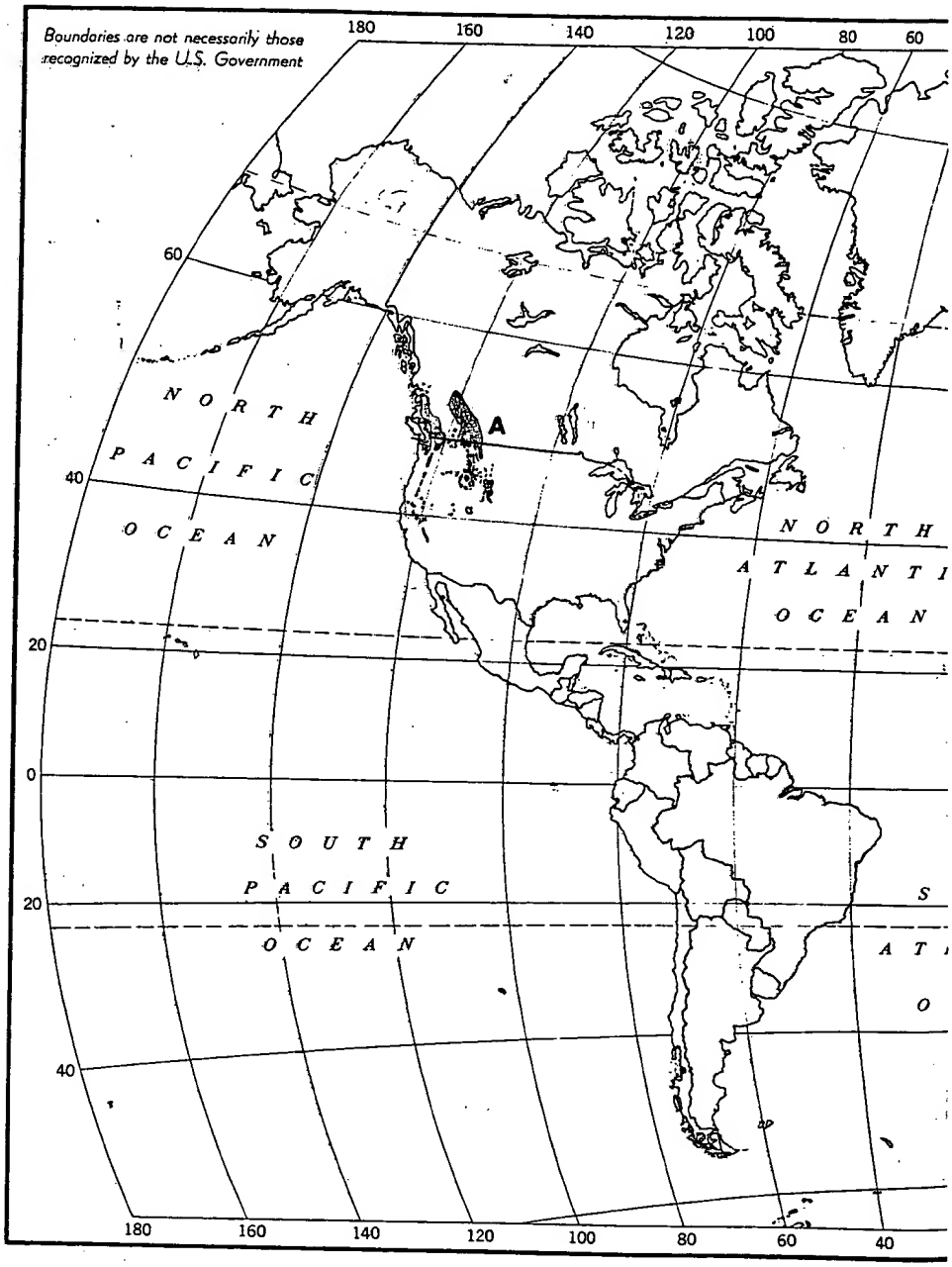
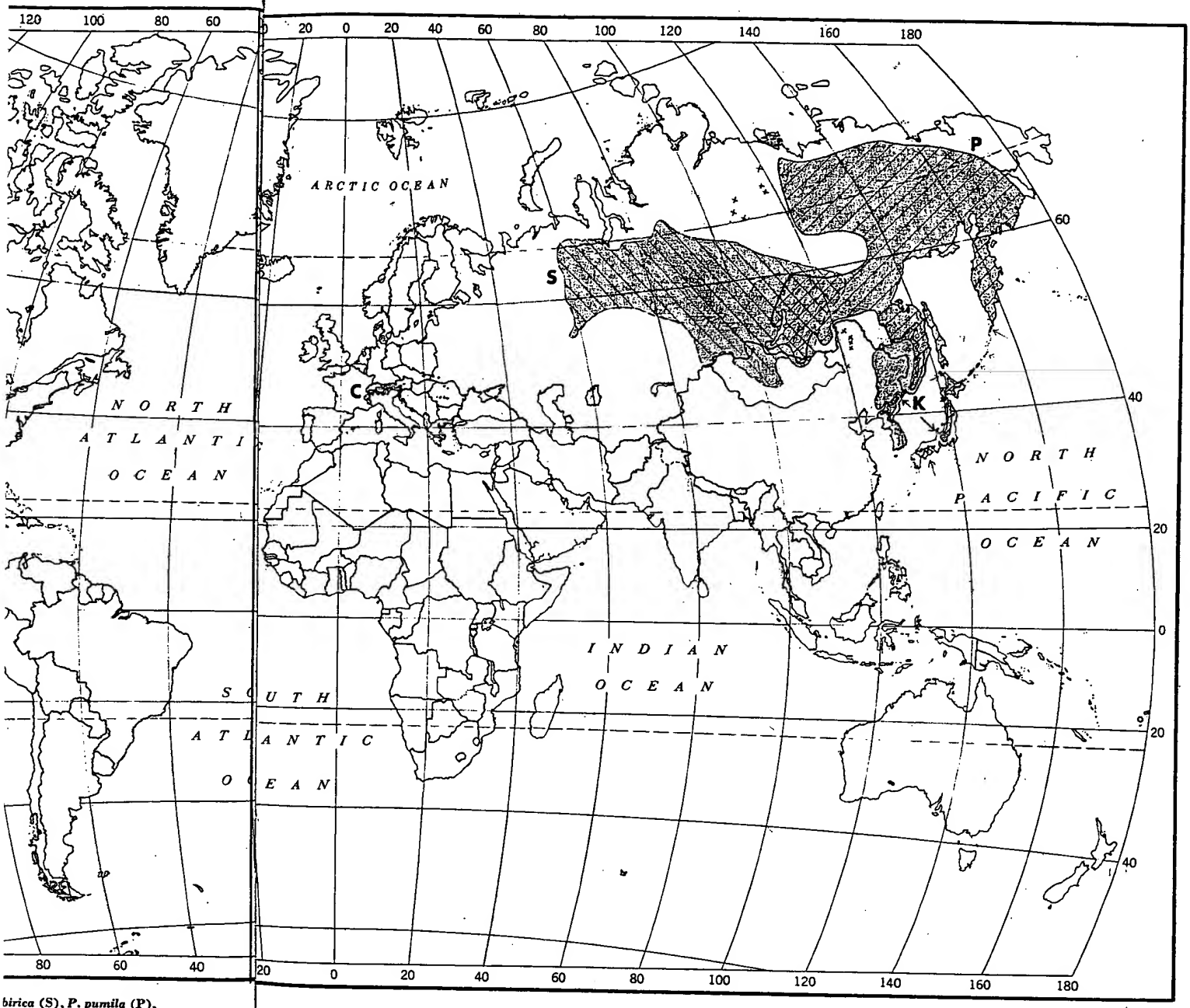
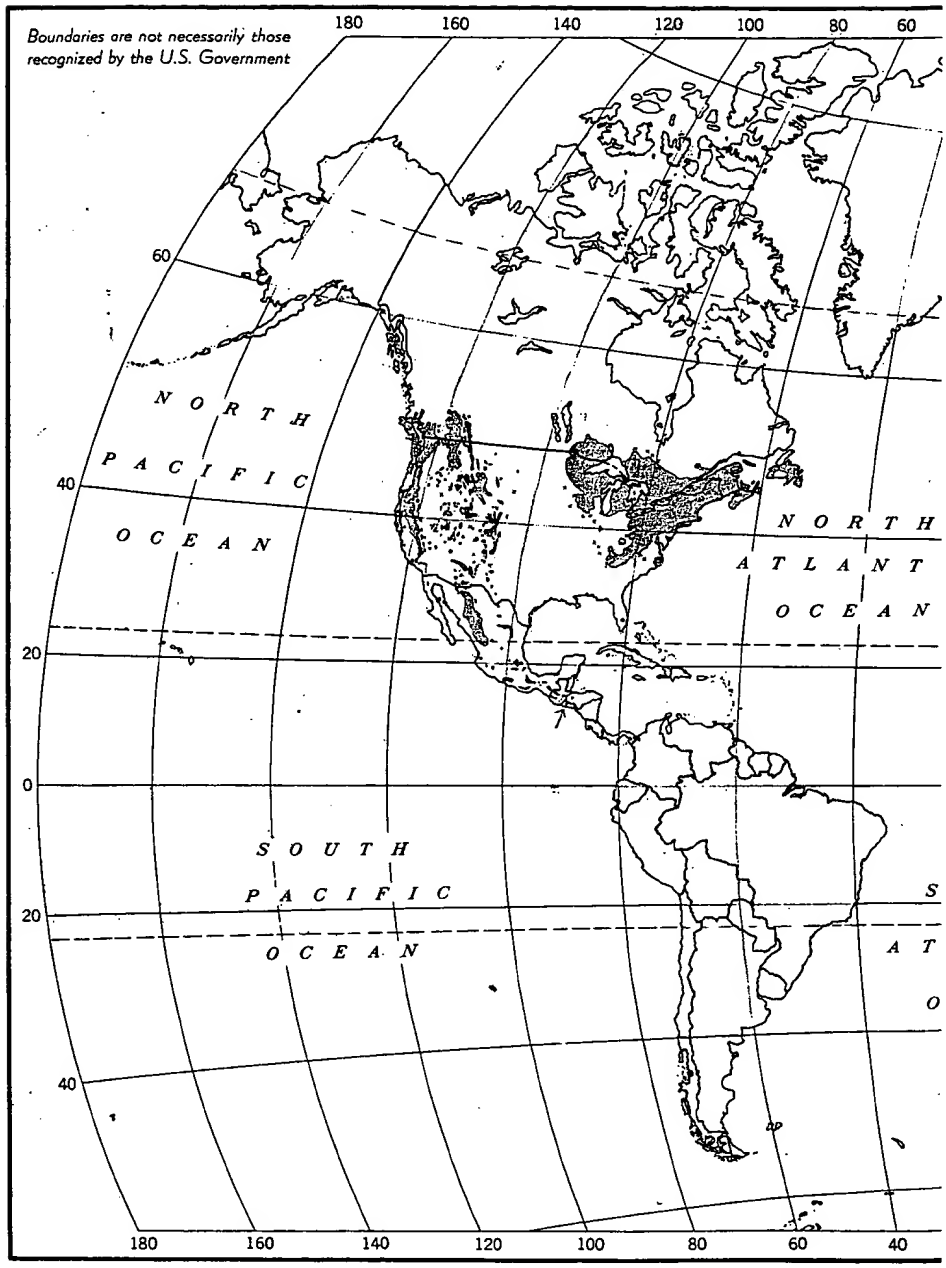


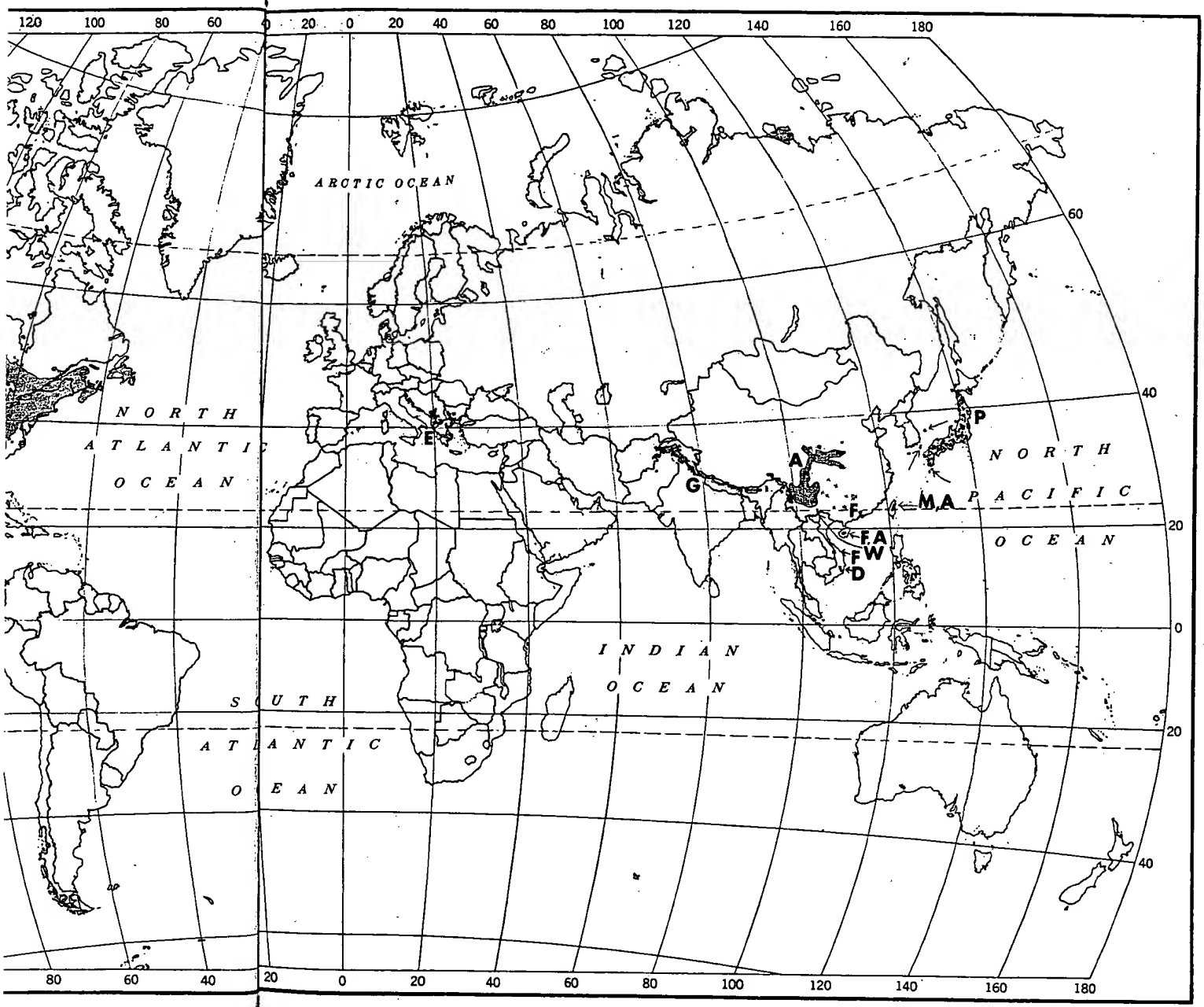
Map. 4. ***Pinus*** **subsect.** ***Cembrae*** **(5 species).** ***P. albicaulis*** **(A),** ***P. cembra*** **(C),** ***P. sibirica*** **(S),** ***P. pumila*** **(P),** ***P. koraiensis*** **(K).**



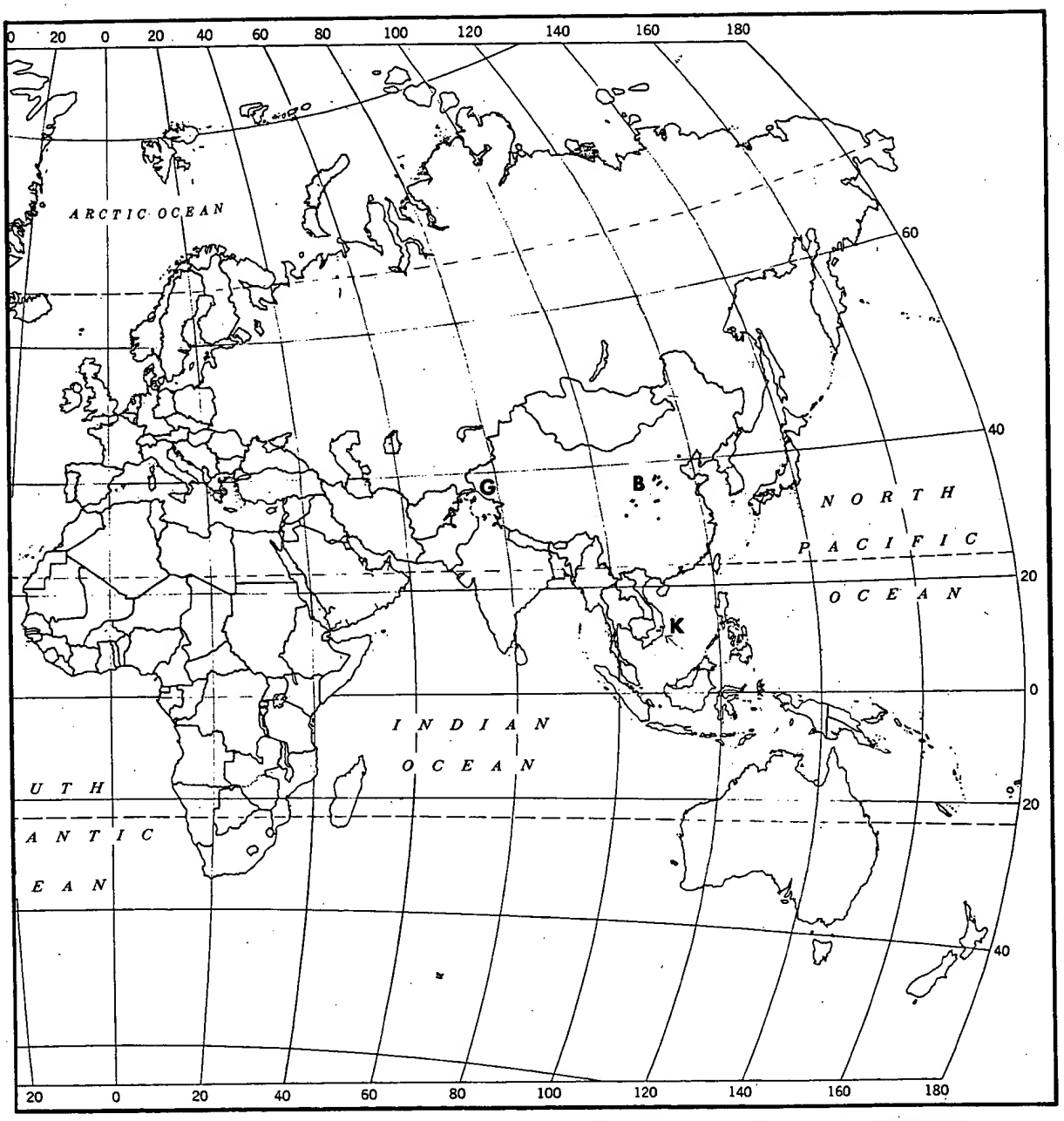
birica (S), *P. pumila* (P),



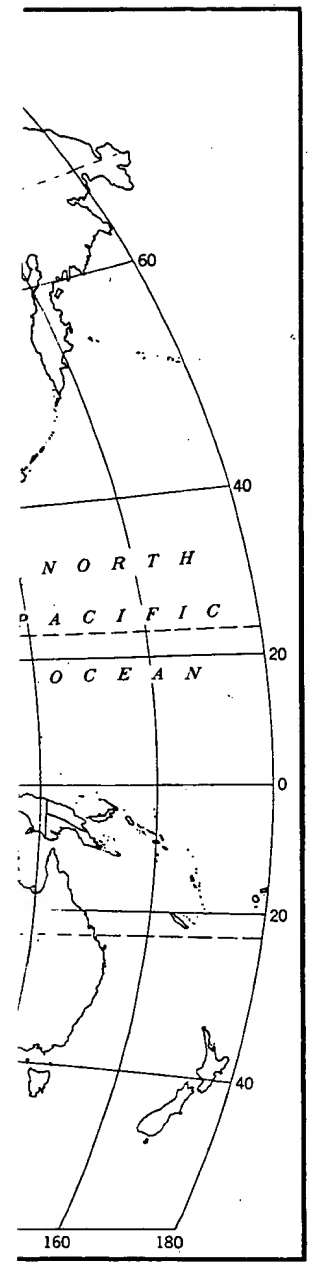
Map. 5. ***Pinus*** **subsect.** ***Strobi*** **(14 species).** ***P. peuce*** **(E),** ***P. griffithii*** **(G),** ***P. armandii*** **(A),** ***P. parviflora*** **(P),** ***P. fenzeliana*** **(F),** ***P. dalatensis*** **(D),** ***P. morrisonicola*** **(M),** ***P. wangii*** **(W).**



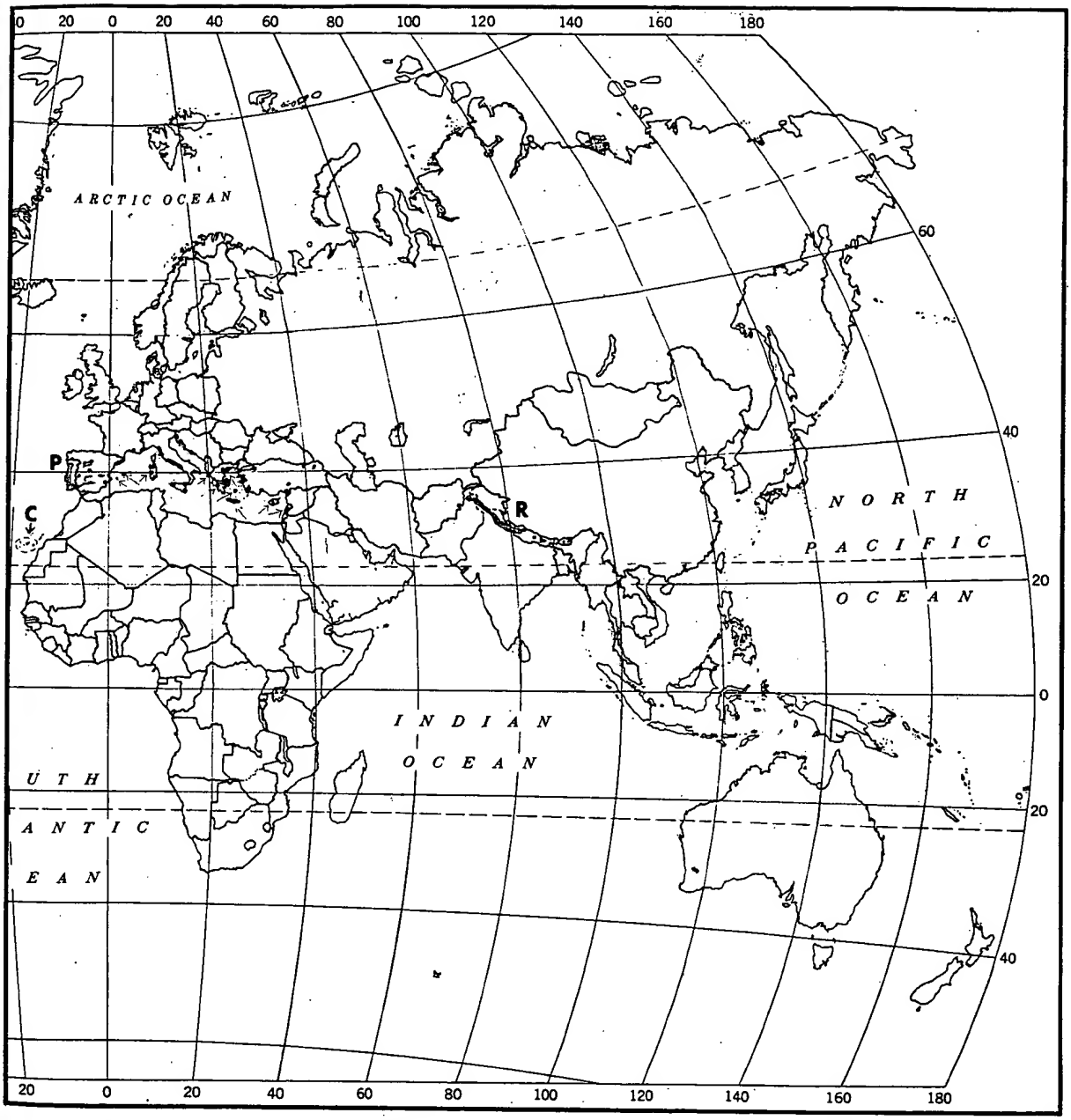
andii (A), *P. parviflora* (P),
).



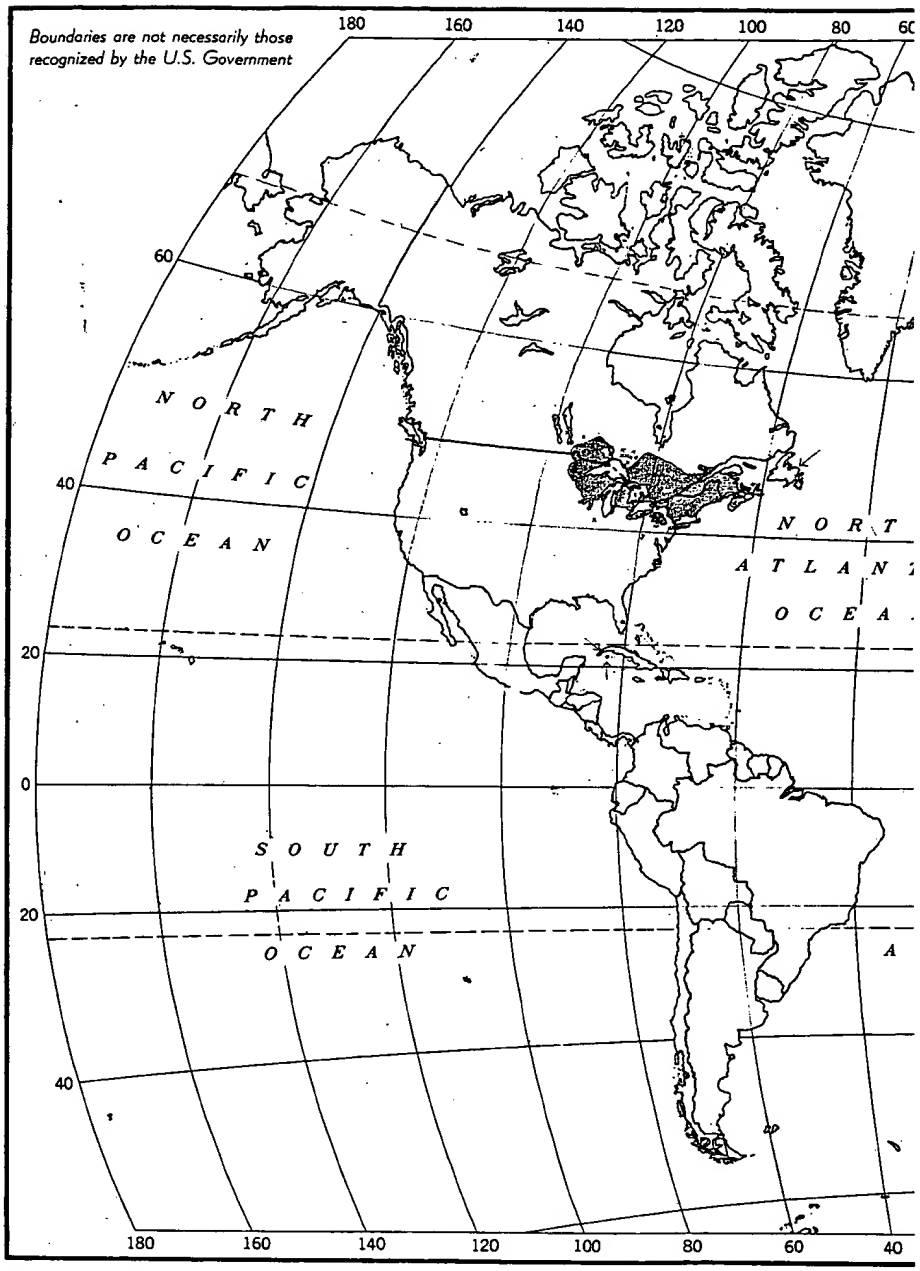
Map 6. *Pinus* subsect. *Gerardianae* (2 species, *P. gerardiana*, G, and *P. bungeana*, B) and subsect. *Krempfianae* (1 species, *P. krempfii*, K).



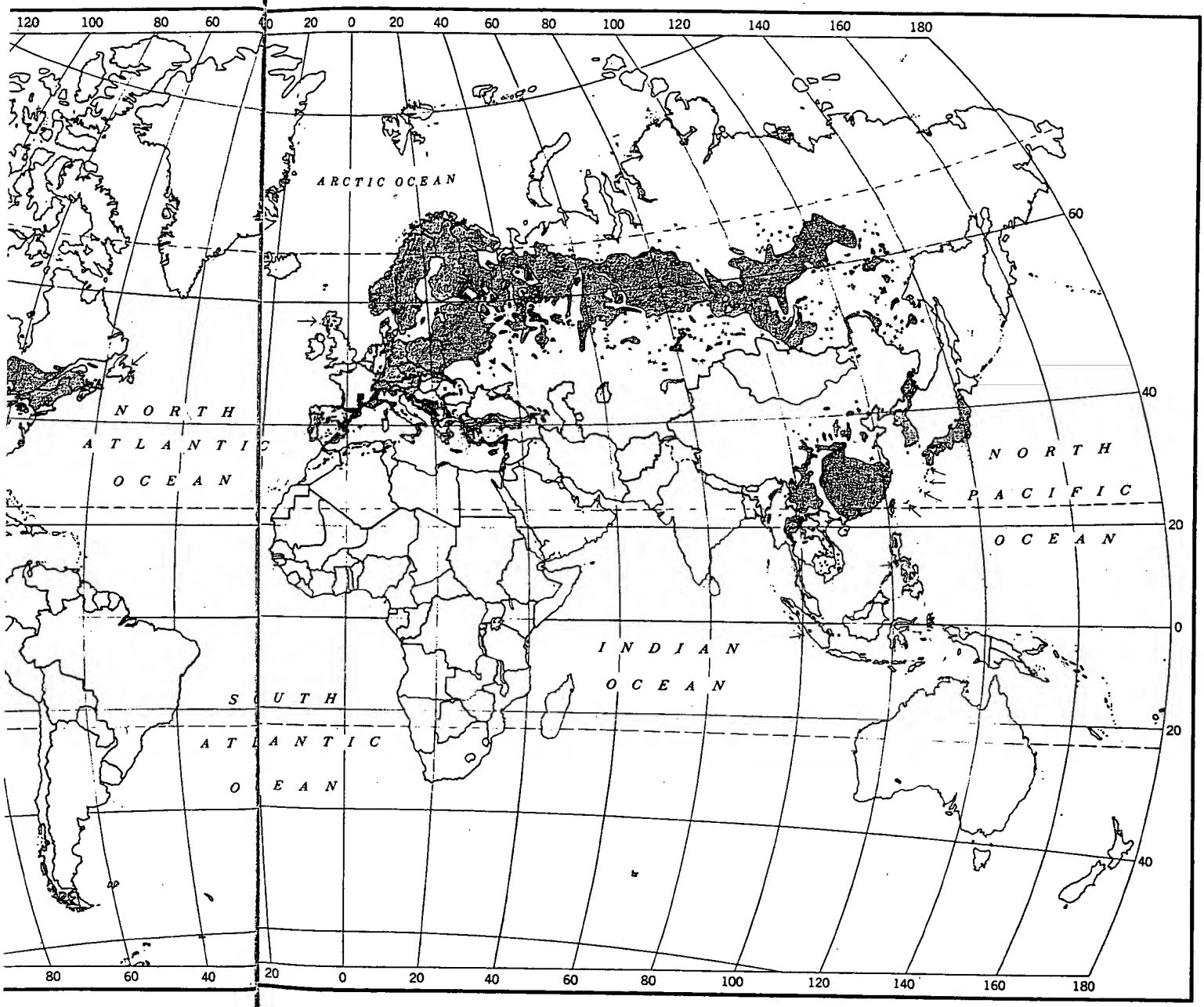
1 species, *P. krempfii*, K).



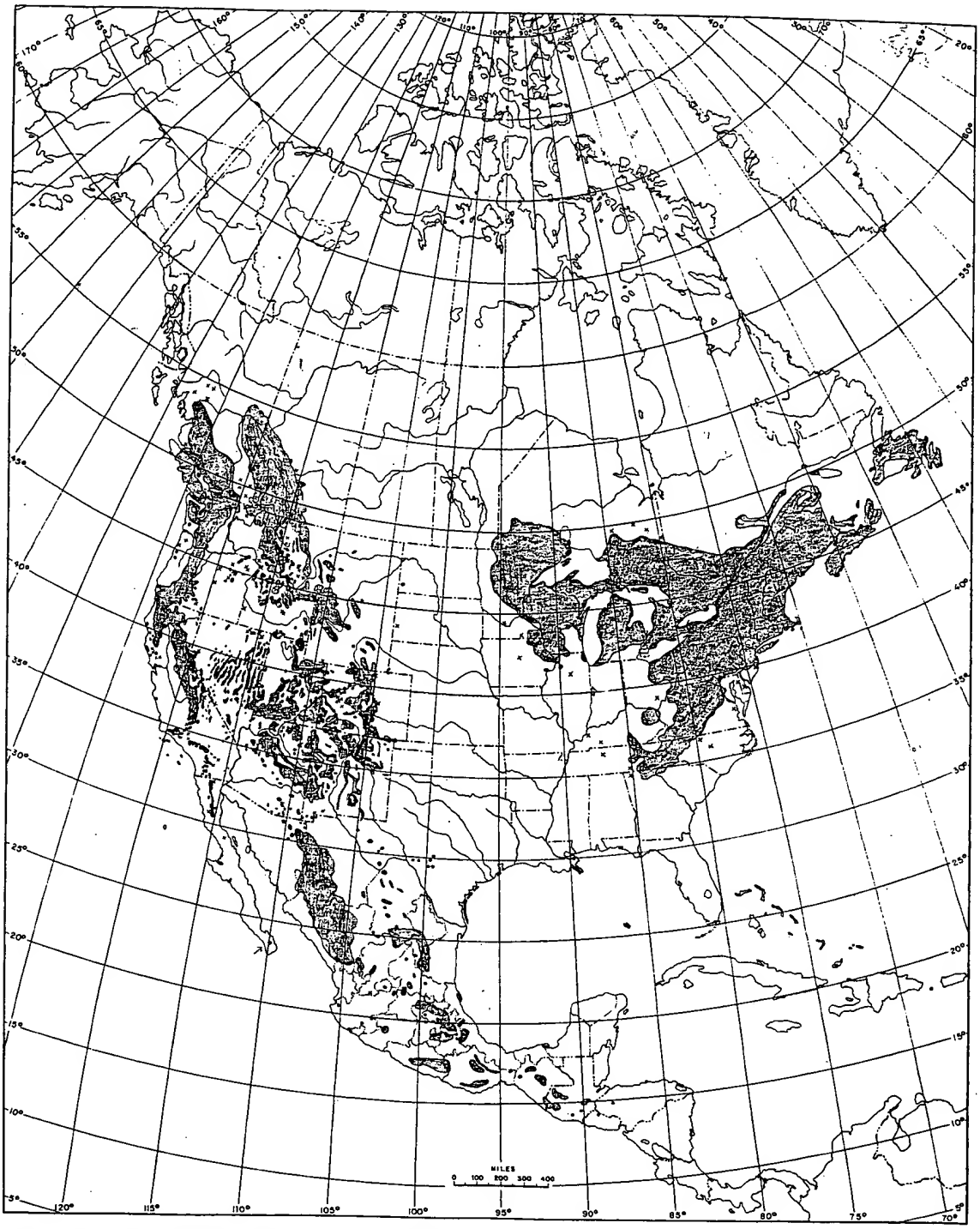
Map 7. *Pinus* subsect. *Canariensis* (2 species, *P. canariensis*, C, and *P. roxburghii*, R) and subsect. *Pineae* (1 species, *P. pinea*, P).



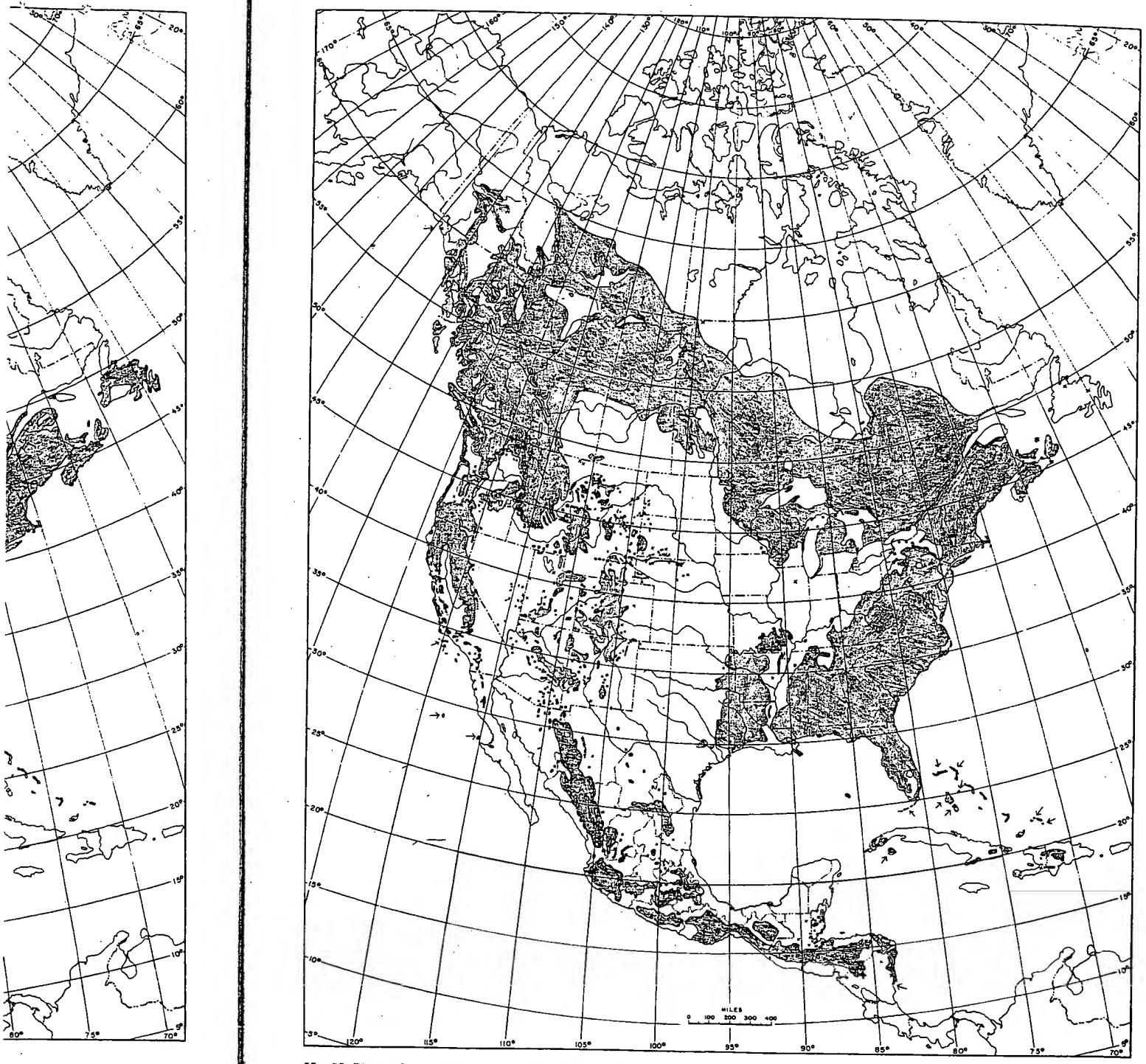
Map 8. *Pinus* subsect. *Sylvestres* (19 species).


120 100 80 60 40 20 0 20 40 60 80 100 120 140 160 180
ARCTIC OCEAN
NORTH ATLANTIC OCEAN
NORTH PACIFIC OCEAN
INDIAN OCEAN
SOUTH ATLANTIC OCEAN
60
40
20
0
20
40
80 60 40 20 0 20 40 60 80 100 120 140 160 180

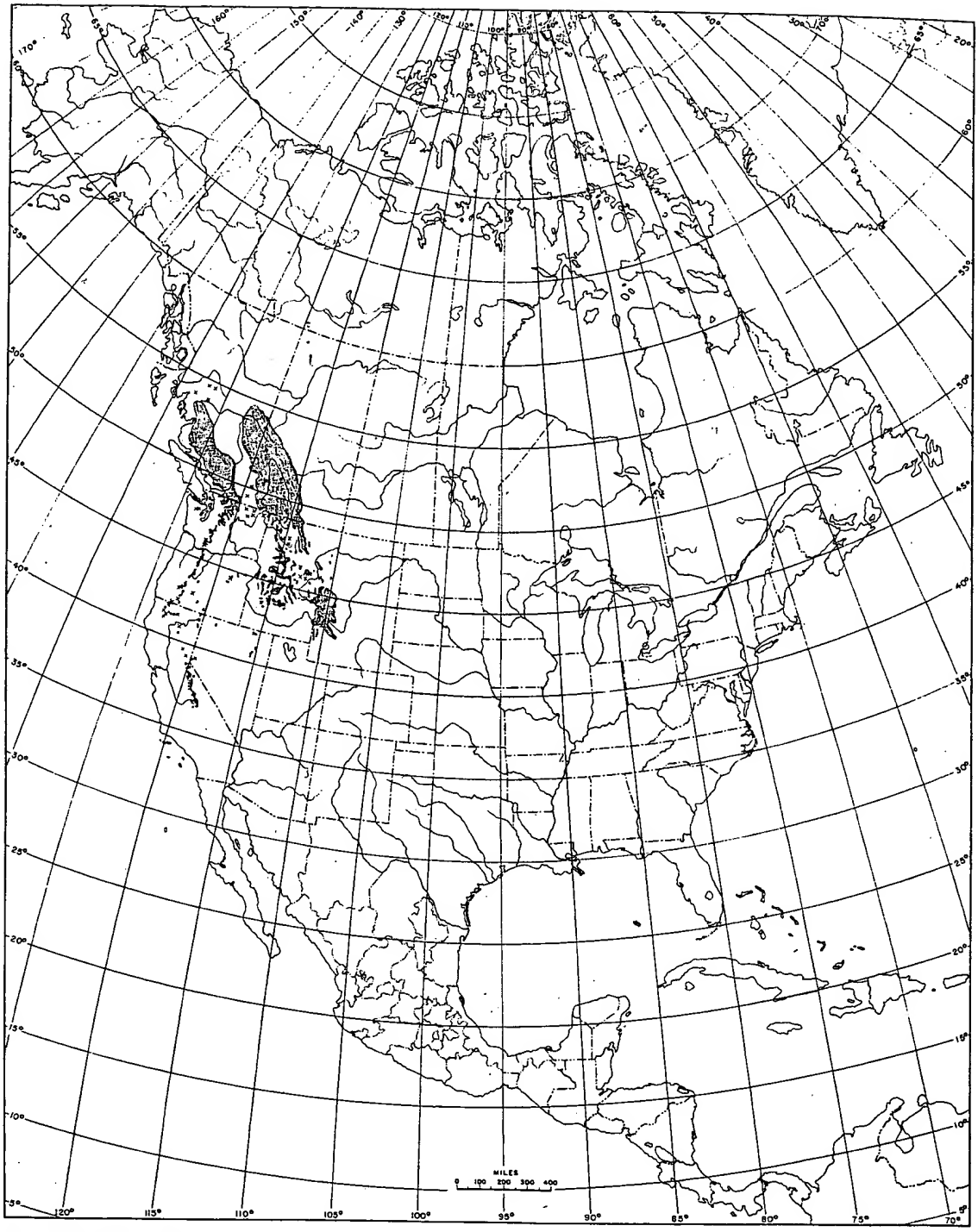
Map 9. The genus *Pinus* in North America (59 species).



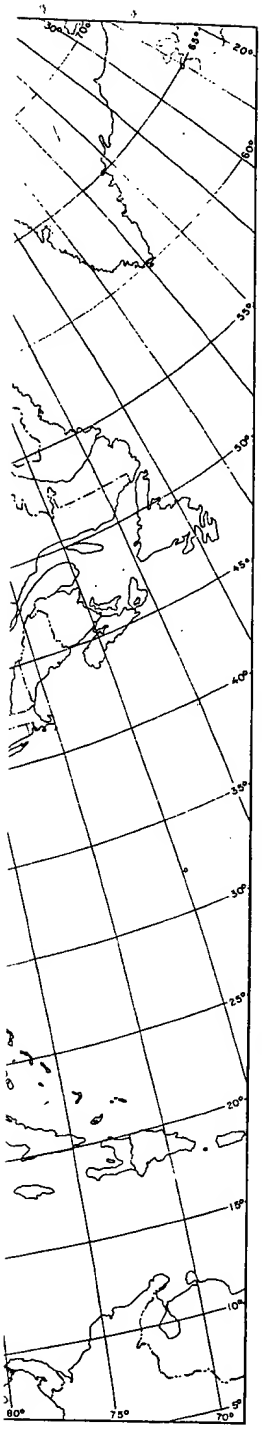
Map 10. ***Pinus*** **subgen.** ***Strobus*** **in North America (17 species).**

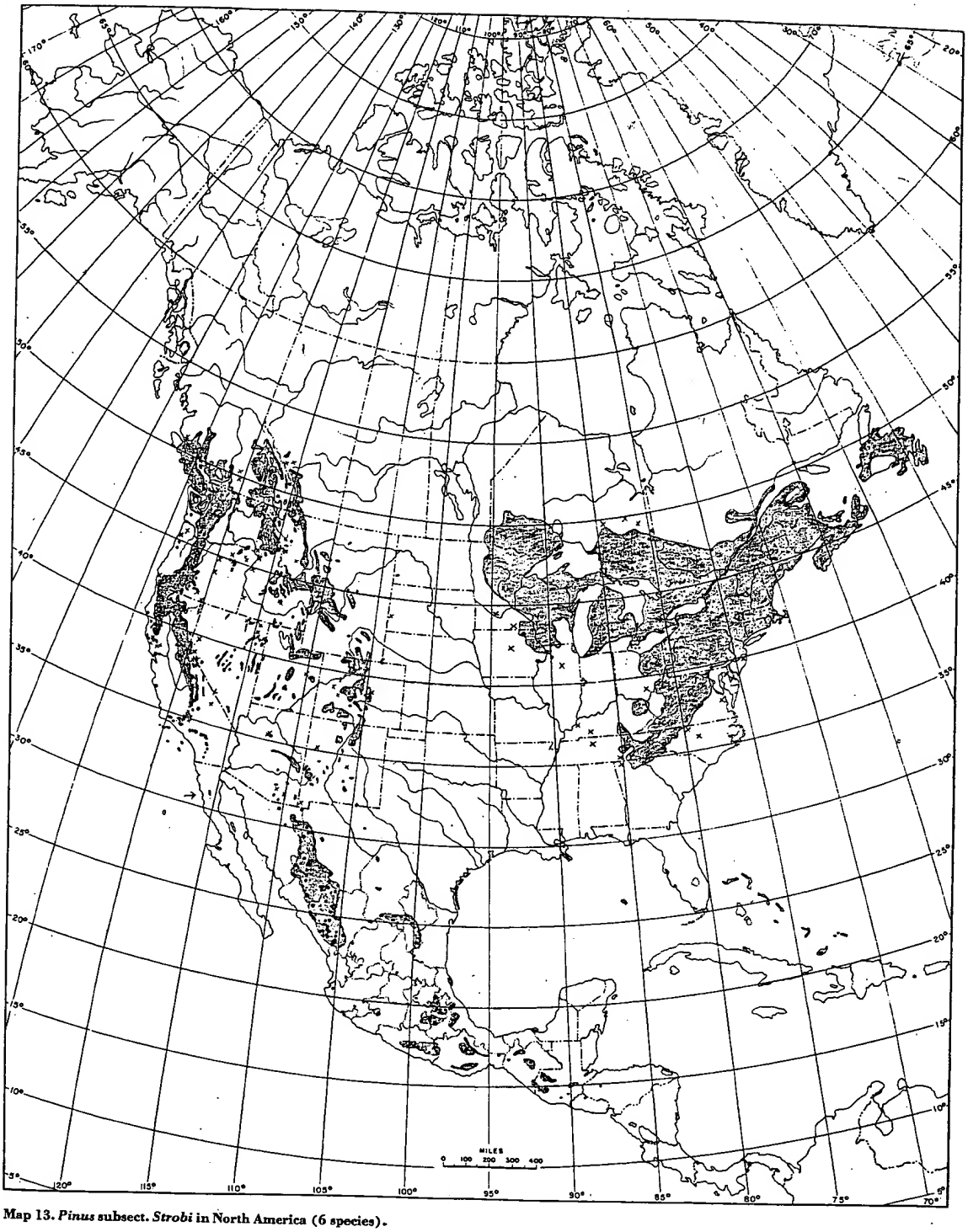


Map 11. ***Pinus*** **subgen.** ***Pinus*** **in North America (42 species).**

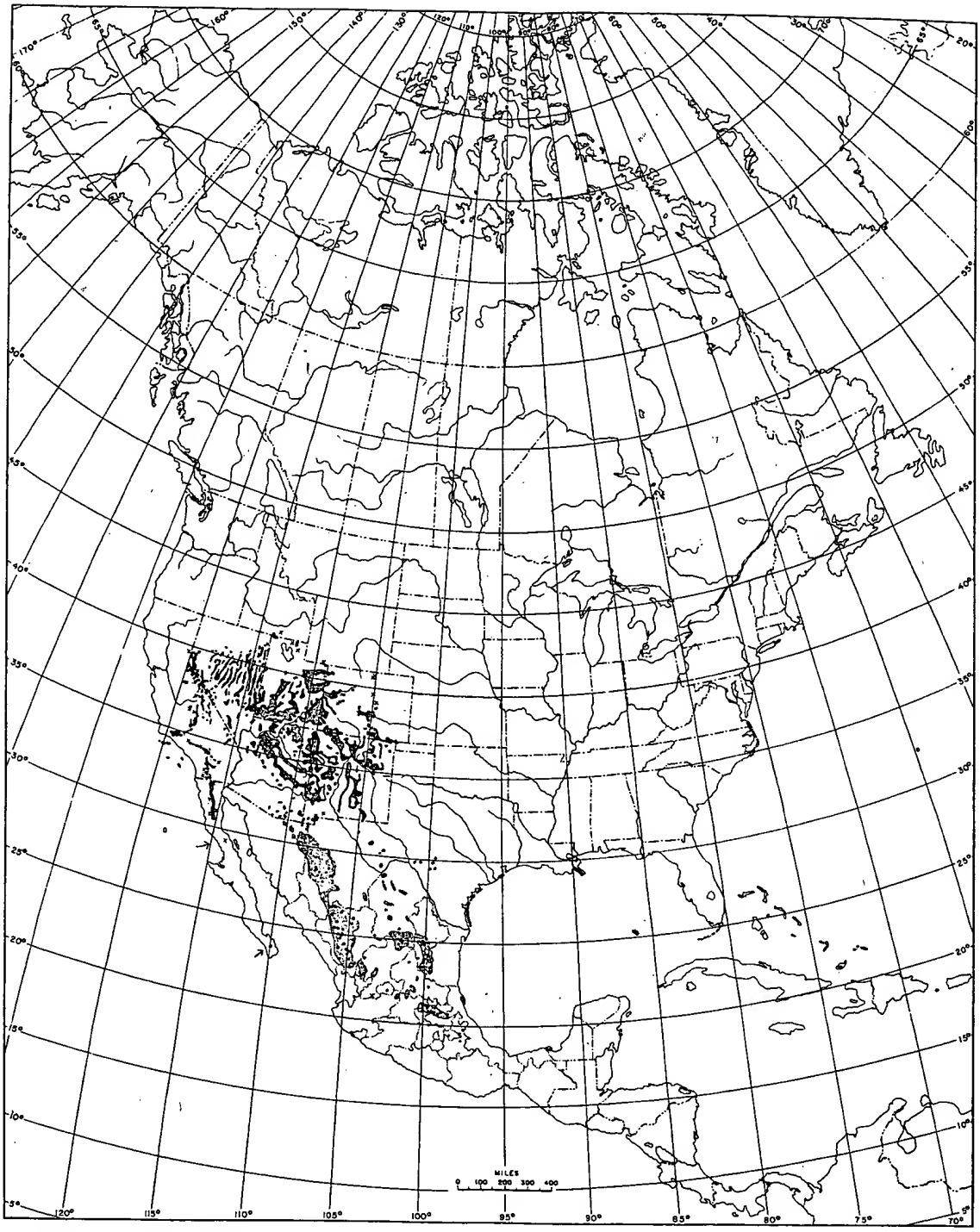


Map 12. ***Pinus*** **subsect.** ***Cembrae*** **in North America (1 species,** ***P. albicaulis*****).**

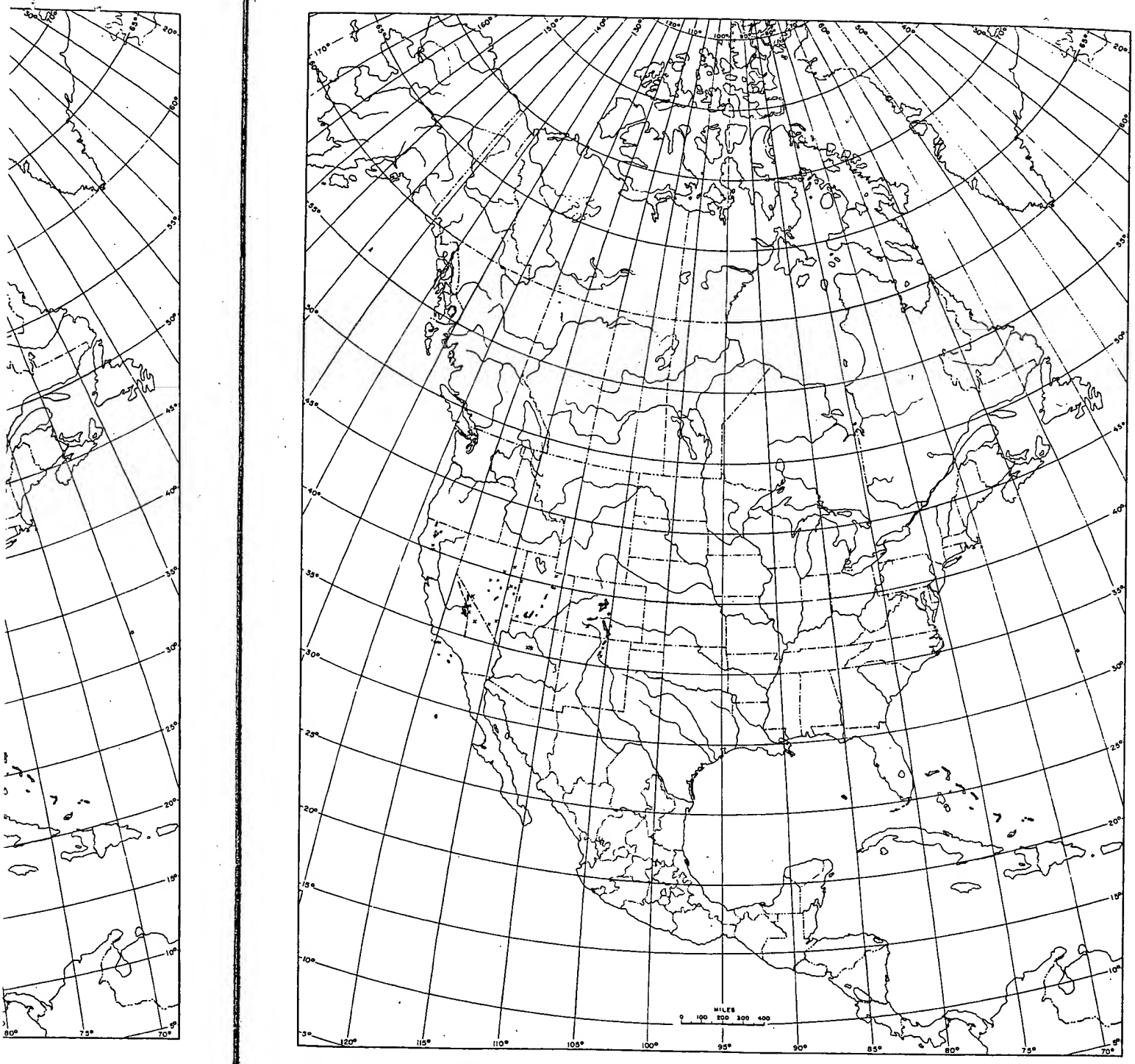




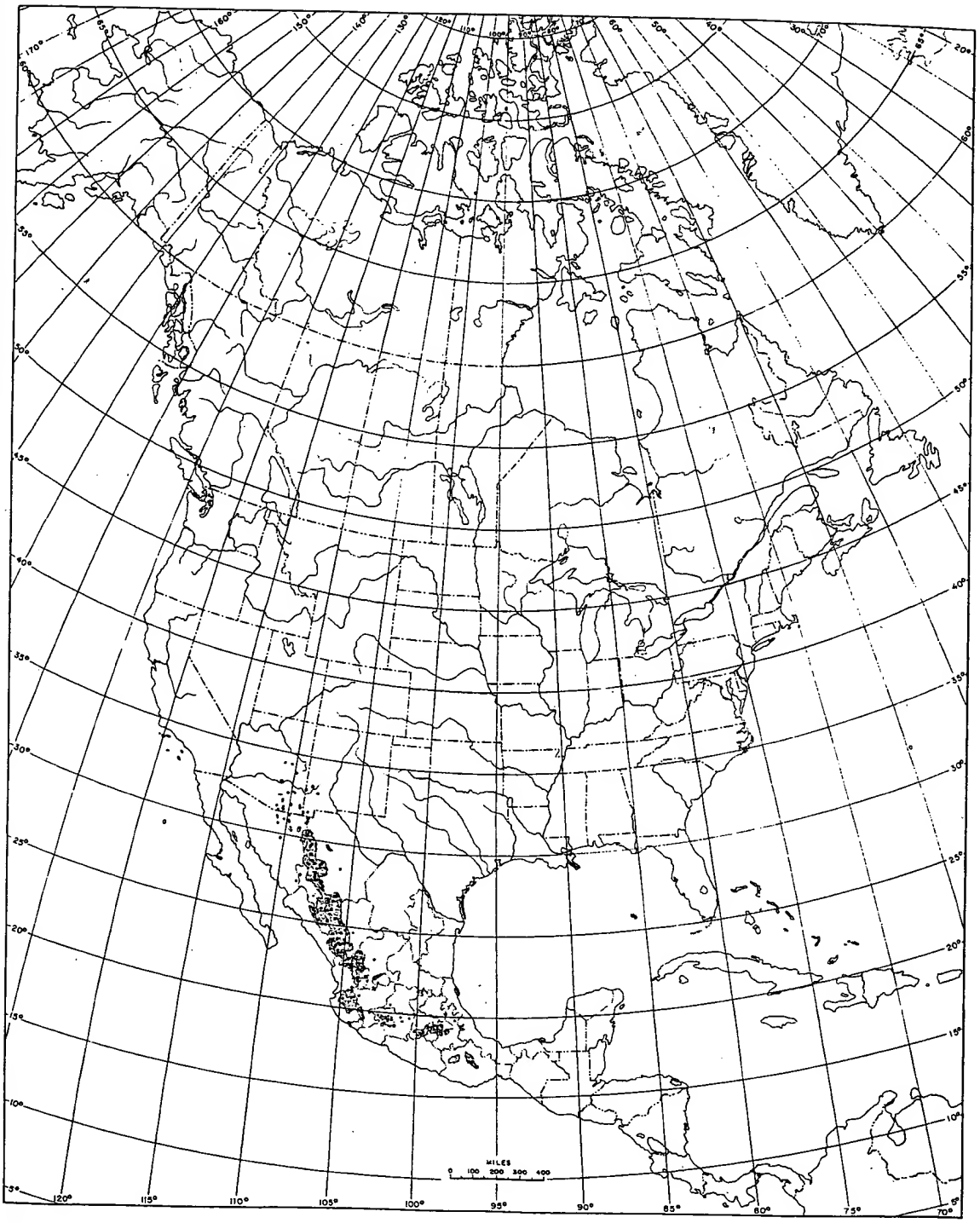
Map 13. *Pinus* subsect. *Strobi* in North America (6 species).



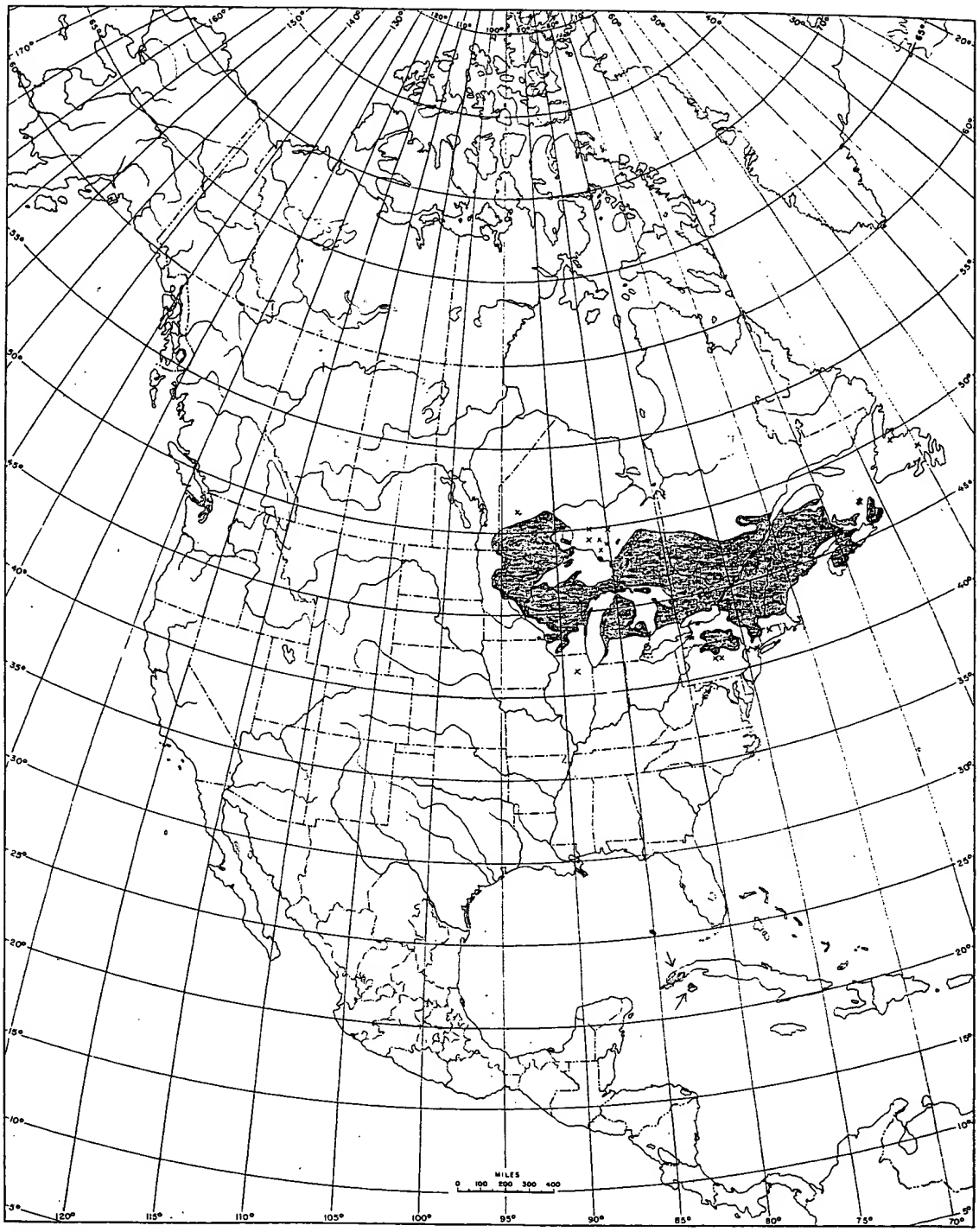
Map 14. *Pinus* subsect. *Cembroides* (8 species).



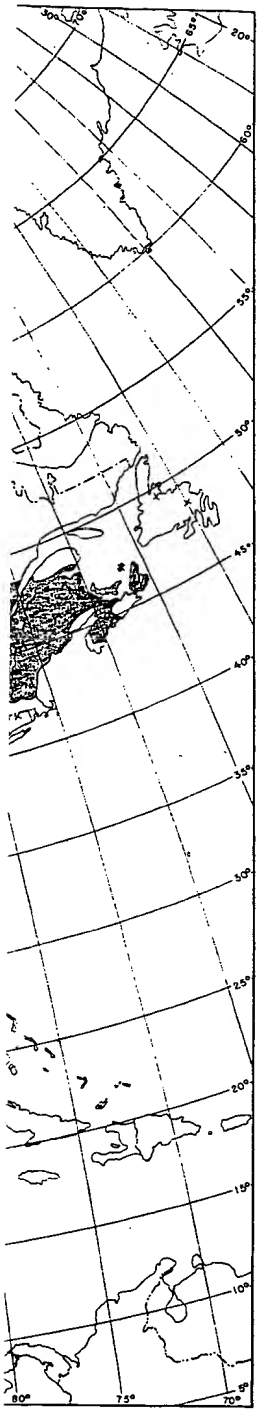
Map 15. *Pinus* subsect. *Balfourianae* (2 species). *P. balfouriana* (California, west of broken line), *P. aristata* (east of broken line).

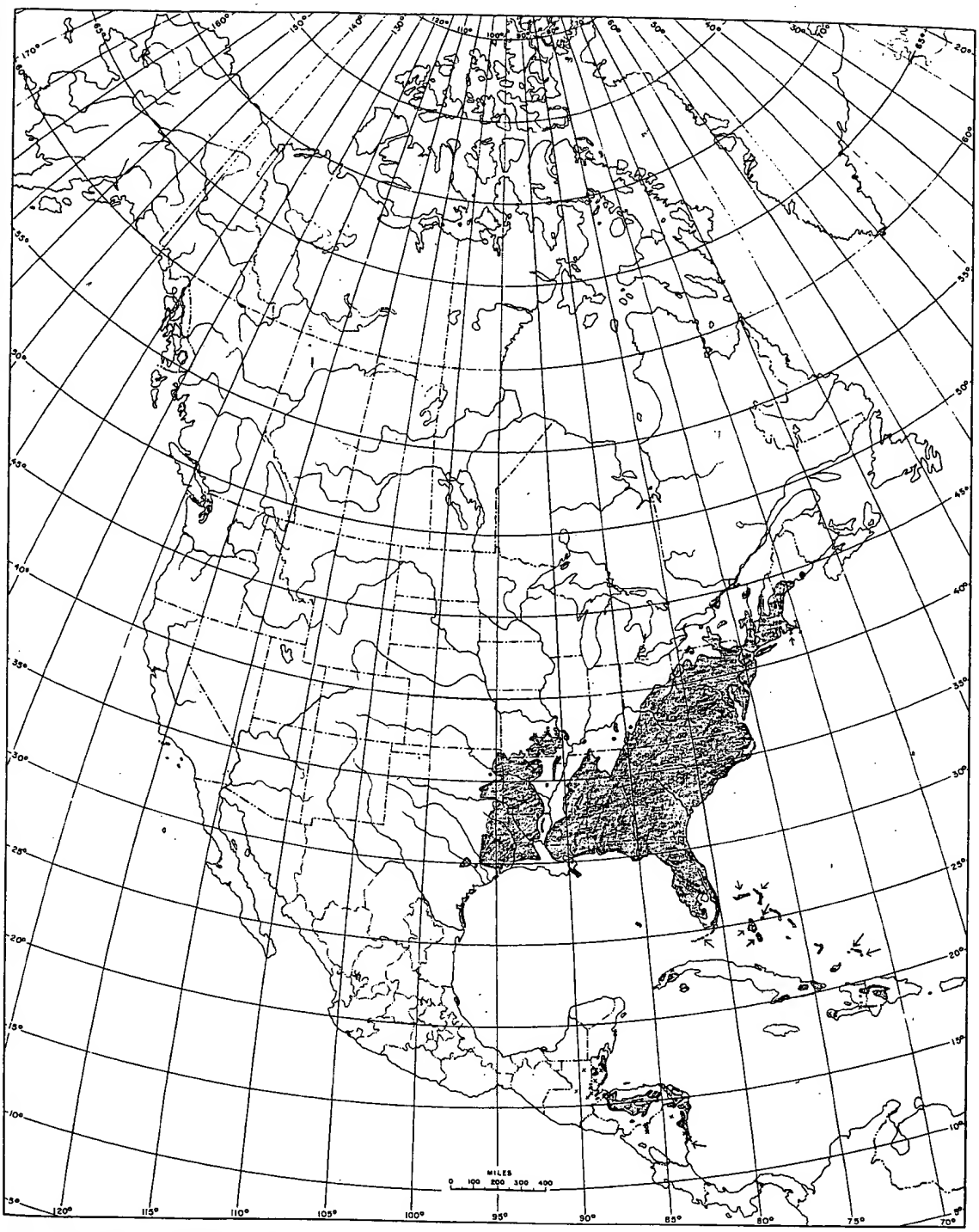


Map 16. ***Pinus*** **subsect.** ***Leiophyllae*** **(2 species).**

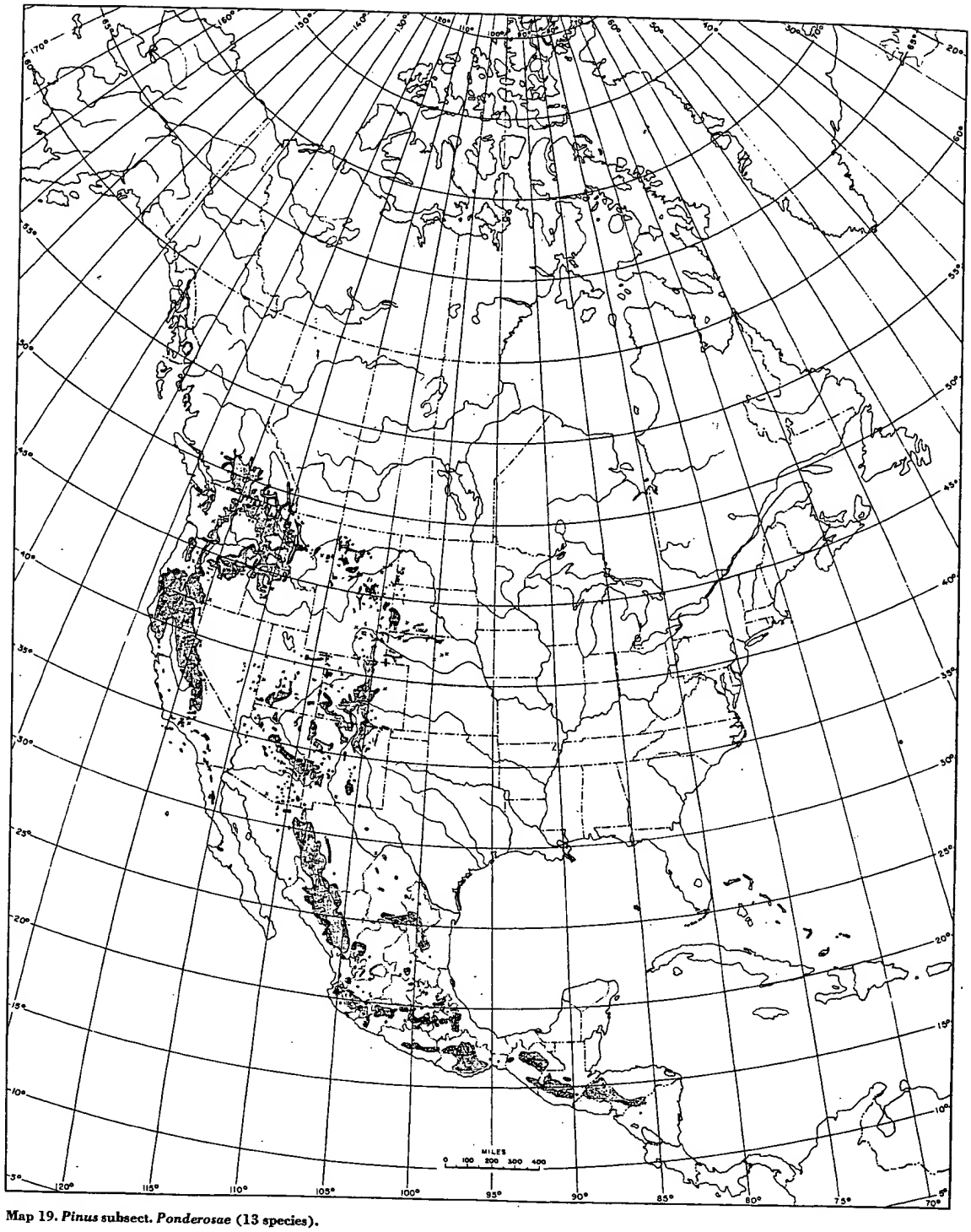


Map 17. ***Pinus*** **subsect.** ***Sylvestres*** **in North America (2 species),** ***P. resinosa*** **(northeast) and** ***P. tropicalis*** **(Cuba).**

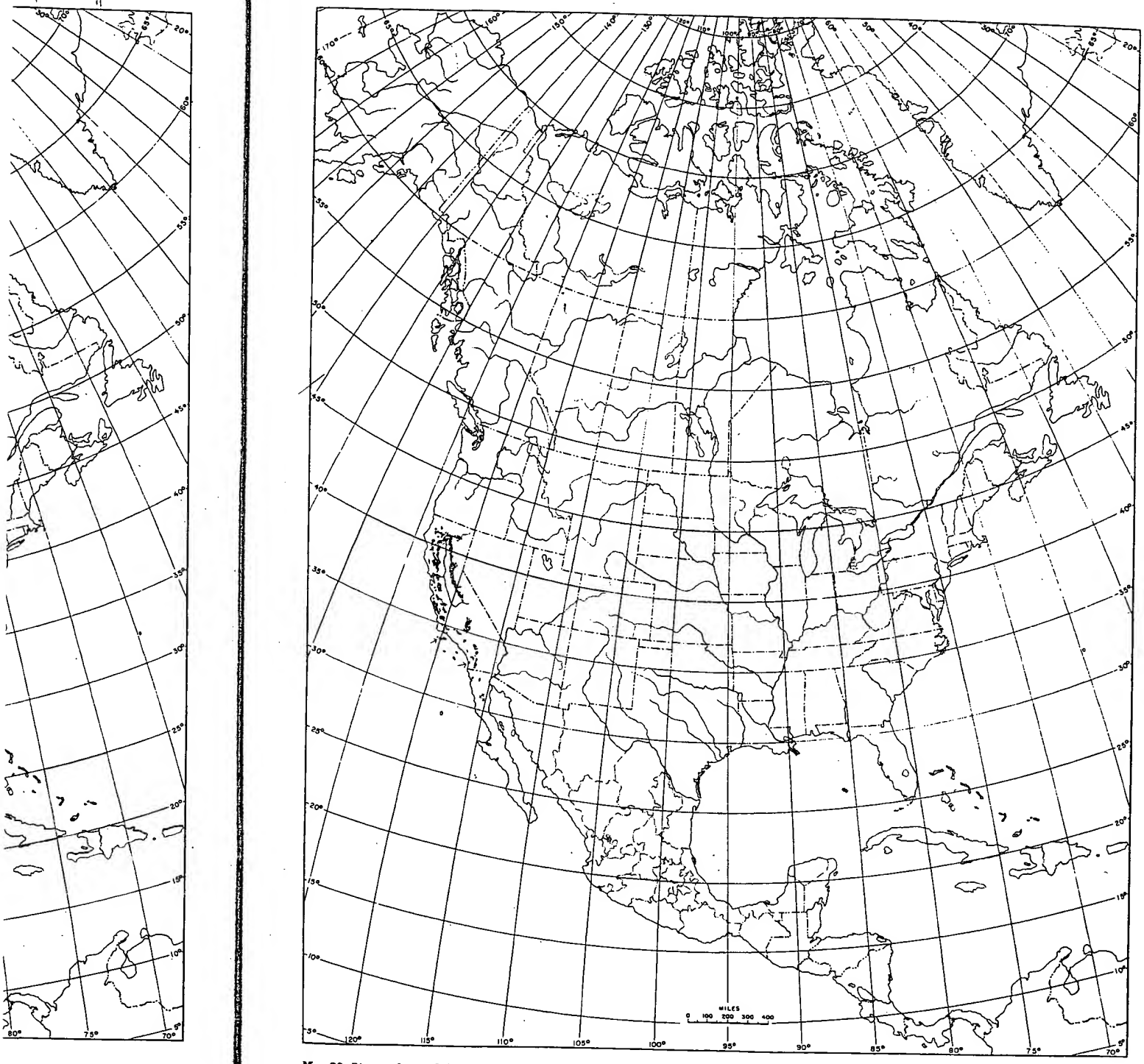




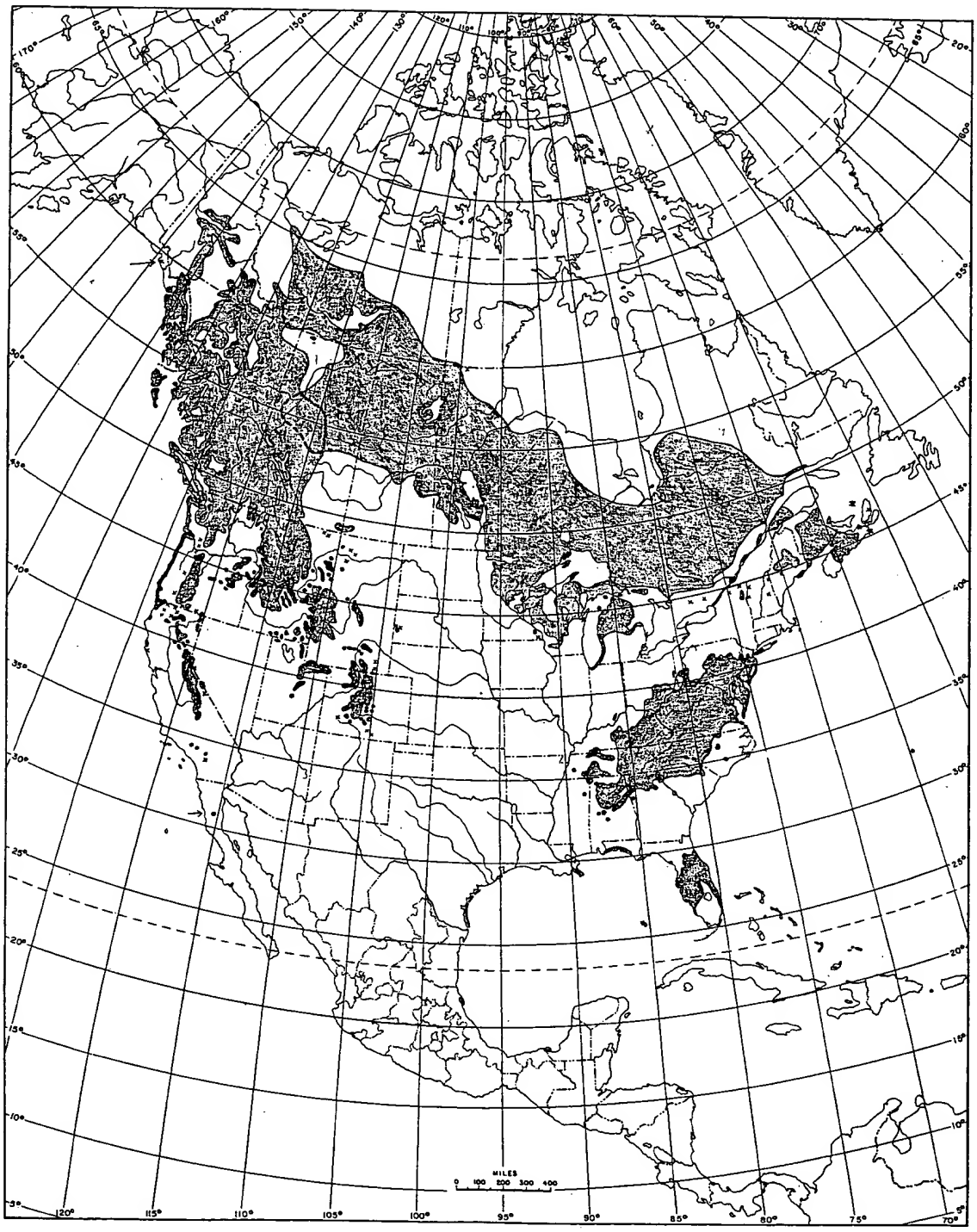
Map 18. *Pinus* subsect. *Australes* (11 species).



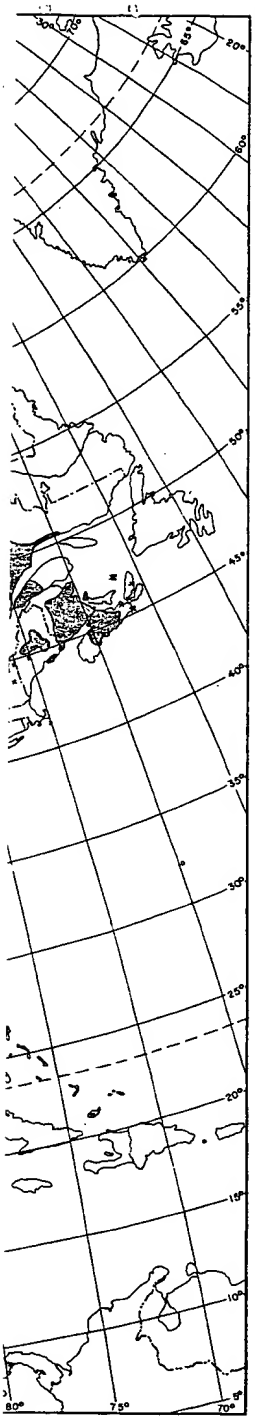
Map 19. ***Pinus*** **subsect.** ***Ponderosae*** **(13 species).**



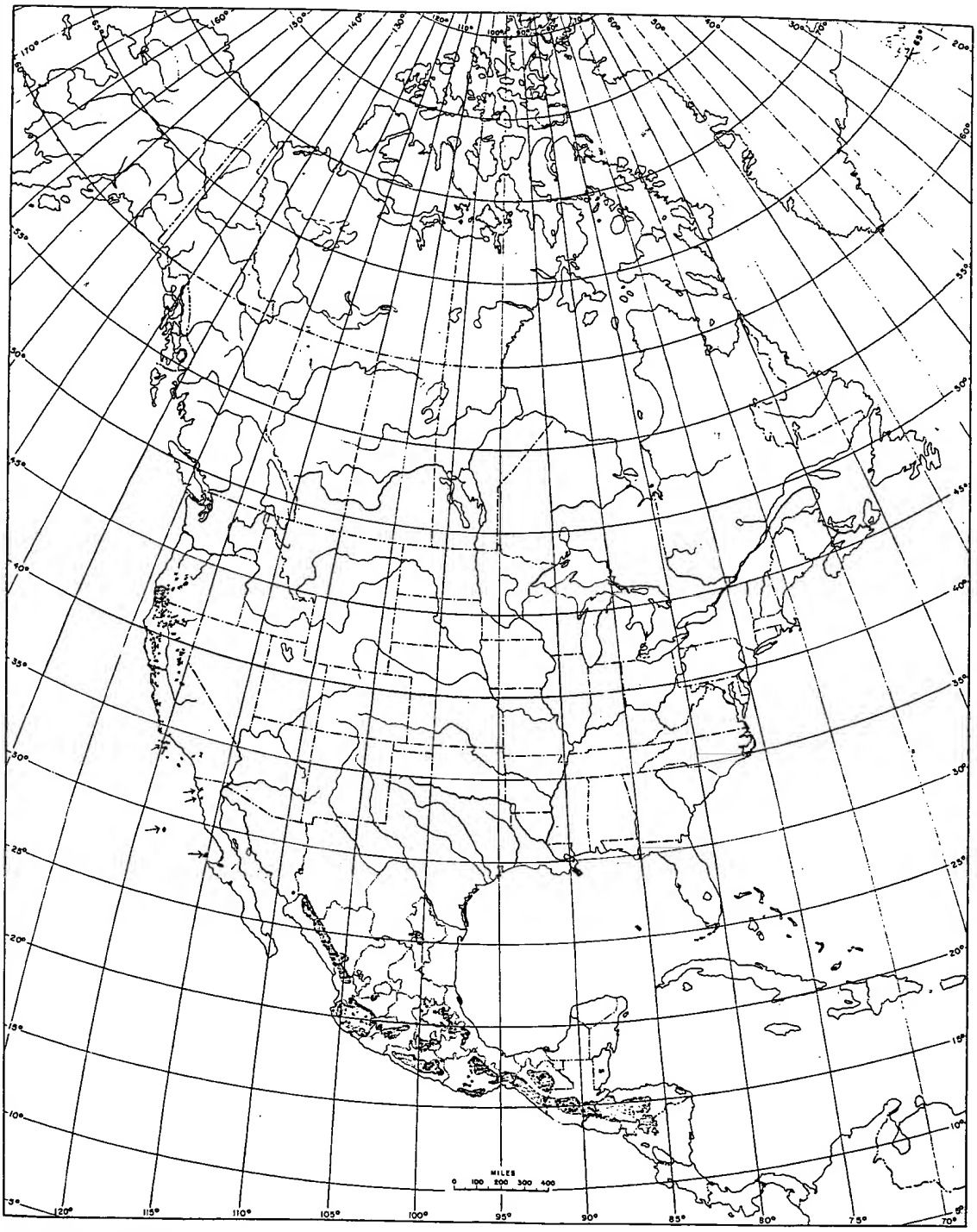
Map 20. ***Pinus*** **subsect.** ***Sabinianae*** **(3 species;** ***P. torreyana*****, 2 arrows).**



Map 21. *Pinus* subsect. *Contortae* (4 species). *P. contorta* (western, east to dotted line), *P. banksiana* (northern, west to broken line), *P. virginiana* (eastern), *P. clausa* (Florida).



rthern, west to broken line),



Map 22. *Pinus* subsect. *Oocarpae* (7 species).

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